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Contents for March 27, 1930

VOLUME 104, NUMBER 13

Copyright, 1930, by McGraw-Hill Publishing Company, Inc.

Tower Excavator Performance and Costs..... 510
By MORRIS W. GILLAND

Adding Stories to a Steel-Frame Building..... 516
By MAX ROSNER

Design of Reinforced-Concrete Freight Terminal.... 519
By M. HIRSCHTHAL

Constructing Long Viaduct of Concrete Arches..... 524
By MERRILL BUTLER AND A. L. ENGER

Natural Gas to the Fore in Western Fuel Markets.... 527

160-Ton Tunnel Shield Moved on One Trailer..... 530

Additional Data on New York's Midtown Tunnel.... 531

Editorial 507 Job and Office 532 Letters 535
News 537 Equipment 543 Unit Prices 545

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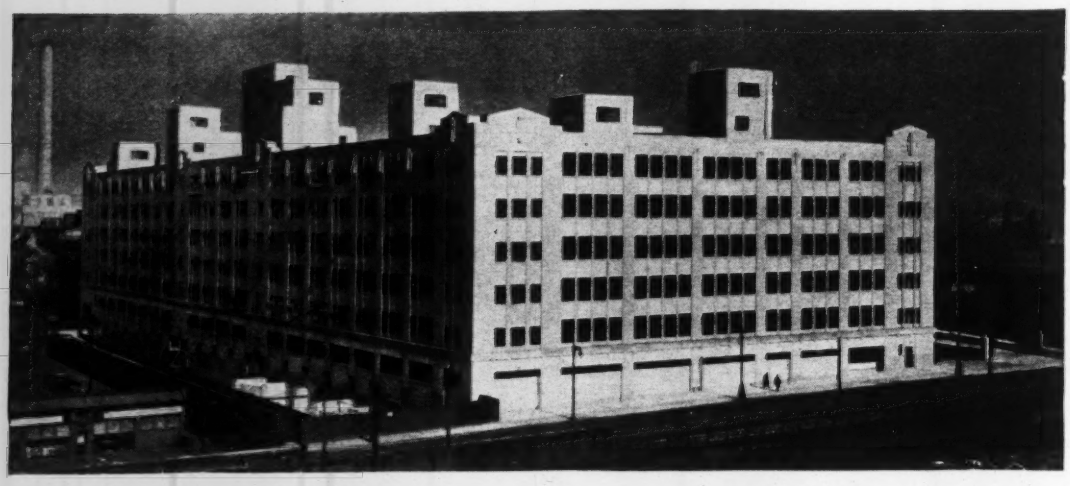

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A McGRAW-HILL PUBLICATION — ESTABLISHED 1874

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, MARCH 27, 1930 Number 13

A Bad Example

FEW engineering projects of comparable magnitude have suffered as many delays and vicissitudes as has the Wanaque project of the North Jersey District Water Supply Commission, now finally completed. Even to outline the many changes in plan and in direction which have been made would be lengthy repetition; this has already been done in previous issues, notably that of Dec. 13, 1928, p. 889. The fact that work which was begun in 1918, on a $20,000,000 project of no technical difficulty, has just been completed tells its own story of vacillation, inaction and inefficiency. Responsibility for this state of affairs should not be placed too hastily. Construction of the project was in the hands of a commission which acted as an agent for eight municipalities with differing requirements, changing personnel and, to a certain extent, mutual jealousies. The commission had no power to issue bonds, but was dependent upon funds supplied by the municipalities concerned. Thus, although technically an independent body, it had, in effect, eight masters. This setup was adopted because it seemed the only one possible under constitutional limitations; it has not been successful. States approaching the subject of regional improvements will do well to avoid a similar pitfall; New Jersey, which has other projects imminent, is already seeking a better solution to the problem of administration.

Bold and Commendable

A PLAN to avoid the evils that have resulted from such makeshift, awkward and insufficient measures as have been employed to provide a general water supply for a small portion of the North Jersey metropolitan district—and sewage disposal for much the same area—and that would at the same time meet other pressing needs of that district and of other parts of New Jersey as they arise is embodied in a bill now before the New Jersey Legislature. The bill is commendable for its boldness in grappling with a great problem that now confronts many states of the Union and for doing it in a way that conforms to fundamental principles of local self-government everywhere. New Jersey being mostly urban and rapidly becoming so in all parts, the bill divides the entire state into four regional districts, each possessed of full governmental powers so far as regional needs are concerned. This is the first attempt ever made to set up a complete system of governmental machinery to provide and operate public works and utilities for large regional areas having common engineering needs. The New Jersey bill does this in a way that is as simple as it is bold. It creates a new and larger unit of municipal government, restricted to public works and utilities serving two or more municipalities or counties, and, within the limits indicated, gives this unit the power to do anything a city or county or a private company could do, subject to the same state control as is exercised over cities and counties and subject also to consent, in important respects, of the cities and counties directly affected. The bill here broadly outlined promises to meet and solve New Jersey's regional problems, which are many and acute. It points the way toward governmental machinery for regional needs wherever such needs exist.

Businesslike Contracts

AFTER some six months of discussion and delay the power contract bids for Boulder dam have at last been decided by Secretary Wilbur of the Interior Department. The basis of the decision is closely the same as forecast fully two months ago—namely, a water price of 1.63 mills per kilowatt-hour and contracts providing withdrawal rights for specified states and municipalities which may, if fully exercised, absorb some 90 per cent of the total. It is a reasonable and businesslike decision, dealing equitably with all interests concerned and making early construction possible. Doubts of the ability of Boulder dam power to compete with the steam power produced by low-priced natural gas are answered by the fact that the contractors already have free access to such steam power and yet are willing to purchase Boulder dam power at the price mentioned. The decision terminates a remarkable period of argument and solicitation, including many contentions of governmental units for exclusive power allocation and opposing demands for fixing a low power price for the benefit of users and a high power price for the benefit of the basin states which are to receive part of the surplus over operating and fixed charges. It remains to be seen what weight the conflicting demands of these interests will have with Congress. The time has now come to make appropriations for construction. If these were long delayed, after the years of bitter opposition which the great undertaking has had to overcome, it would be a serious reflection on democratic government.

Land vs. Water Traffic

CHICAGO'S business district cannot be reached from the north and west without crossing navigable waters. Since Lake Michigan bounds it on the east, this leaves unobstructed access only from the south. Tugs, sand scows and other harbor craft require the bridges to be opened frequently, and thereby interrupt and render irregular the main streams of travel within the city. Brief periods of closed bridge hours morning and night (7 to 9:30 a.m. and 4:30 to 6:30 p.m.) have long been granted by the War Department, but a recent request to augment these periods by 30 minutes and to permit a closed period from 12:30 to 2 p.m. on Saturday has been denied by the department. In support of the contention for longer periods the city's traffic engineer, Leslie Sorenson, reports vehicular traffic four times as dense as fifteen years ago, while navigation has shown no mate-

rial increase. To aggravate the situation the lake level has risen, and many more vessels than for several years past require bridge openings. A new hearing has been asked. The interests of other similar situations as well as the needs of Chicago make it desirable that this hearing and the findings thereon give due consideration to the relative changes in use of land and water facilities for commerce. Reasonable allocations of time based on changing conditions rather than on fixed dogmas set up in former eras are demanded by present conditions.

Compressed-Air Laws

MORE attention has been given to the working conditions and welfare of the sandhog than to those of any other class of construction labor. New York's existing compressed-air laws are humane and safe, and are considered standard by the construction industry throughout the country. Working under these laws and protected by rigid medical inspection, the sandhog is much safer than many of his fellow workers in other building trades. Serious cases of bends are becoming rare in modern compressed-air work, and fatalities due to bends are almost non-existent. Yet in the face of remarkable records of safety on air jobs working under the adequate existing laws, three bills have been introduced into the New York Assembly to amend the present statutes. Two of these bills would require T-head locks on all compressed-air work. Such locks are unsuitable on most jobs and virtually impossible to use on building caisson work. The third bill would reduce the working period under air during a 24-hour period from 25 to 50 per cent, depending upon the pressure. In view of present laws, such reduction is wholly unnecessary and unwarranted from the standpoint of safety to the health of the sandhog. It is merely an excuse to provide work for additional compressed-air workers. The proposed schedule would increase the cost of air work to an extent making it almost prohibitive for high pressures. The threat of the proposed bills has already held up calling for bids on New York's Rutgers St. subway tunnel under the East River, and it is likely that other contemplated work has been affected. Engineers and contractors should exert every effort to defeat these bills.

Manslaughter

A DESIGNER of an engineering structure whose failure caused the loss of human life has been indicted for manslaughter. It is a grave charge. In the case of the New York coal pocket, whose collapse led to the indictment in question, engineers may gain some satisfaction from the fact that the designer was practicing engineering without a license. However, this is merely a reflection on the administration of the engineer license law and does not remove the stigma cast on the profession by the collapse of the coal pocket. For years leaders of the engineering profession have decried incompetent designing, have fought "canned" designs sold with an order of material and have tried in every possible manner to guard the public safety by curbing such designs and such designers. Concern for public safety is a prime requisite of structural engineering. It has become a legacy, to be guarded and developed. Experience reveals only one sure way to accomplish this—to make the designer responsible. Such a ruling was seen as a direct aid for capable and competent engineers. True, the structures designed by such engineers are sometimes the center of catastrophe; human frailty makes this inevitable. For such cases punishment could be tempered, and although loss of prestige will usually result, this was considered necessary and regarded as one of the risks of business; so we said that the negligent designer should be punished. But in most cases we thought only in generalities; the form of punishment was seldom considered. Now the district attorney and the Grand Jury of Bronx County have brought engineers face to face with an indictment for manslaughter. These officials have done their part for public safety. Are engineers ready to support them? Are they ready to stake their reputations, their freedom even, on the structures they design? In short, are they willing to pit their structures against a possible conviction for manslaughter? We believe they are. We believe structures can be designed that are safe. And we believe engineers, everywhere, even though not without sympathy for the individual, will welcome any conviction that will advance the cause of public safety and raise the standards of the engineering profession.

Where Water Dictates

SOLUTION of the water-supply and conservation problems that face southern California will furnish opportunities for outstanding accomplishments in these fields of engineering endeavor during the next decade. Here is a region with a population of more than two and one-half millions growing at a rate several times faster than the national average, situated in a semi-arid climate. It forms one-third the area of California, but receives only a few per cent of the state's natural runoff waters. This combination of conditions has forced the region into a remarkable struggle.

Assured adequacy of water supply will guarantee a continuation of the phenomenal growth of the southern California communities, whereas failure to solve the water problem will throttle future expansion. To add to the difficulties, the problem is one which must be solved in advance of actual need, for, in the prophetic words of William Mulholland, spoken some time ago, "if you wait until you *have* to have water, then you won't need it." The struggle will be waged on a vast scale, and only if Los Angeles and her sister cities display the same courageous spirit that built the original aqueduct can they hope to prevent the stagnation that may follow threats of water shortage.

As to the present local supplies, whose limitations have been made worse by a cycle of years of subnormal rainfall, they must be developed to the full to bridge the period of ten years or more before the Colorado River supply will be available for use. The Los Angeles County flood-control program now under way, with its provisions for replenishment of groundwaters, will aid the agricultural demand which yearly is forced to go deeper and deeper into the gravels to find water. Domestic consumption, necessarily high because of the warm, dry climate, must be controlled by strict co-operative efforts. Without doubt the time has come, as witnessed by several active experiments, when the reclaiming of sewage water for industrial purposes and agricultural use through replenishment of the underground reservoirs must be resorted to. Much public resistance may have to be broken down before this procedure will find approval, but the effort is worth while. Only by strenuous efforts in these various fields can the present resources be made to

keep pace with the probable growth of the communities for the next few years.

Behind this immediate problem lies the huge undertaking of bringing Colorado River water to this territory—at a cost that may reach $250,000,000. This scheme, now only in its preliminary stages, will tax not only engineering skill but also the determination and faith of the various communities to provide an adequate water supply for themselves and for the generations of the future. While it is being worked out the country at large will follow it with particular interest because of the realization that southern California faces more urgent and more complex water-supply problems than any other community.

Tower Excavators as Levee Builders

THE traveling tower excavator used on the Mississippi River has notable qualifications as a levee-building machine. It digs, carries and places earth within distances up to 700 ft. It lays down a levee with remarkably little rehandling of material. It meets the exacting conditions of wide, shallow borrowpits. Of all levee machines on the river it is least hampered by pit-floor or bank conditions that limit the travel of heavy loads. A decade of levee construction on the Mississippi has given only the long-boom dragline excavator a comparable record of production and economy in large-section levee work.

Has the tower excavator as useful a future in levee construction? This query is pertinent because of the more exacting requirements of the new superflood levee operations. Without any modification of borrowpit restrictions, a new levee section half again as large as any previous section has to be constructed. Far greater widths of pit than heretofore must be spanned by the travel of the drag bucket. In round figures a 600-ft. bucket swing has to be increased to at least 700-ft. swing, even if every ground-gaining possibility of two-trip layout is utilized. Levee enlargement imposes the same space requirements, as this operation corresponds to the second trip in constructing new section. For these reasons the new levee work means that the bucket travel must be lengthened if the tower excavator is to maintain its old records of output and economy.

Two means of increasing bucket travel are available: Towers can be made higher and the cable-span longer without reducing bucket size or losing the advantages of the gravity run-back; or the present towers can be set farther apart and a smaller bucket used, with a backhaul line to take the bucket to the rear of the pit. In this year's operations tower heights have been increased in the upper delta, while in the middle delta the present towers have been set farther apart and the buckets equipped with backhaul lines, as illustrated on another page. Because only moderate spans were required this year, buckets have not been reduced in size, and output records have pretty well kept up with past performance. But this has required strenuous effort, and long-time results are bound to exhibit a decline.

The situation has reached a point where it is pertinent to inquire whether an advance in practice is not demanded. Even with towers completely reconstructed for 125 ft. height, which is none too great, the present machines fall below the standards of current equipment-engineering practice. The steam power plant on the Mississippi with its bad water and its long and difficult coal hauls can no longer compete with the diesel and the diesel-electric power unit. Drag buckets and cableway hoists of ten years ago are far less capable than similar equipment of today. In general the present tower excavators, which date back to 1918, are obsolete equipment, despite the excellent upkeep and replacement work performed by the government engineers.

Whether the tower excavator will take on new life by modernization, to match its great levee-building rival, the dragline excavator, is largely a question of contract policy and procedure on the new Mississippi levee work. With few exceptions the score or so of existing tower excavators are owned by the government, and with government competition and contract practices there has for years been no inducement for the contractor to invest in so expensive a machine. Continuing and large-volume levee contracts, however, create a possibility that the contractor may become a purchaser of tower excavator equipment. Already tower machines have been installed by two of the levee contractors. It is to be hoped that this is the beginning of activity to put into the field in a more perfected form a type of machine whose effectiveness as a levee builder has been demonstrated through a dozen years.

Natural Gas

NATURAL gas, used in industry for many decades, acquires a wholly new industrial importance through the conservation laws passed in several states prohibiting waste of the gas produced in enormous quantities from recently driven oil wells. Within the past year or two a former byproduct has become a major element in oilfield operation as well as a factor of great potential importance in the market for fuel and power even in territory as far distant as 1,000 miles from the oilfields.

It is found that the cost of transmitting gas is much less than the cost of delivering equal energy over electric transmission lines. Developments in methods of building gas-pipe lines have therefore been rapid. Field welding on a 200-mile pipe line now under construction in California is progressing at seven times the best rate made on a similar line laid less than a year ago. But pipe-line construction has only begun; it yet remains to market most of the oilfield gas if the conservation laws are to be obeyed.

In some oilfields, both Eastern and Western, gas has been pumped back into the ground for storage, perhaps into shallower oil sands from which the oil previously had been drawn off. However, if a market can be developed, even at a low price, producers will prefer to realize promptly on their assets. Hence the line built last year from Texas to Denver, the lines now being built from South and Southwest to Chicago, and the California developments—the latter stimulated by an oil and gas discovery of amazing richness.

These changes promise to lead to significant results in lowering the cost of fuel and power throughout the territory that can be economically served by pipe lines from the gas-producing oilfields. They are also stimulating remarkable advance in the art of gas pipe-line construction. Both these changes closely affect the engineer, affording him new opportunities and requiring that he familiarize himself with new methods of pipe-line construction and new factors in heating and industrial power problems.

Tower-Excavator Performance and Costs on Three Types of Levee

Outfit for Tower-Excavator Levee Construction—Performance and Costs on New Levee, Set-Over Levee and Levee Enlargement—Possibilities of Improvement to Meet Conditions Imposed by New Superflood Levee Section

By Morris W. Gilland
First Lieutenant, Corps of Engineers
Area Engineer, Central Area, Vicksburg Engineer District, Greenville, Miss.

Tower Excavators occupy a somewhat unique position among levee-building outfits on the Mississippi. Like the dragline excavator long used for the same work and like the hydraulic dredge and the mammoth clamshell dredges put to work in the last year, they are essentially large-capacity machines. They require only a moderate amount of supplementary plant work to produce complete levee. More particularly they are machines especially designed for levee construction under the requirement for broad shallow borrowpits which prevails in the two northern river districts which extend from Cairo nearly to Natchez.

The tower excavator developed out of the necessity of a more economical method of constructing the larger Mississippi River Commission 1914-grade levee section. This section, with its 40-ft. sloping banquette, called for so much greater yardage and longer haul that the prevailing levee-building (largely mule-team) methods were no longer economical. The tower excavator was devised to meet the situation. The first machine was purchased by a contractor. Not many contractors, however, were then prepared to undertake the investment in so costly a special machine. Then came the World War. About 1918 the government began to purchase tower excavators and initiated hired-labor levee building on a large scale. In a few years the M.R.C. forces had a plant of about a dozen tower excavators, most if not all of which are still in service.

The tower excavators in service were designed for levee with a landside banquette and until 1929 they built only 1914-grade levee; their adaptation to the present superflood section is yet too recent to afford any just estimate of the changes needed and the outputs practicable. In the following article 1928 operations are described, with the machines as developed for the 1914 banquette section. Operations on new levee, on set-over levee and on levee enlargement have been selected as examples, and performance and cost records are given for each example. Possible plant improvements are indicated, but mainly the article is a factual statement of specific operations.

—Editor.

FOLLOWING the successful trial of the first tower excavators in 1914, it was decided by the Mississippi River Commission that there should be purchased, from levee funds, enough of these machines to enable a government estimate to be prepared, based on cost to the commission of performing the work with hired labor. This estimate, plus an amount representing a reasonable profit to the contractor, was then to be compared with bids submitted by contractors. The inability of contractors at that time in levee construction to meet, with older methods and equipment, the challenge of the new levee builder resulted in the purchase, between August, 1918, and March, 1921, of nine of these machines in the then Third M.R.C. District. All of these machines are now in the Vicksburg Engineer District, in good working condition, either engaged in construction or available for contemplated levee enlargement.

There has been material improvement in performance during the years that these tower excavators have been in use. Not only have they been used for levee enlargement but entire levee sections have been built, either on a new location or, where sufficient borrowpit area is lacking, by a turnover of the old levee, commonly known as a levee set-over.

The originally well-thought-of performance of 30,000 cu.yd. per month has been increased to well over 180,000 cu.yd. per month with a single ten-hour shift. To illustrate each of the three general types of construction undertaken during the past ten years, there will be described three subprojects accomplished during the 1928 working season in the Central Area of the Vicksburg Engineer District.

A Tower-Excavator Outfit

A tower-excavator levee-building outfit comprises a tower excavator and an assisting dragline excavator. The drawings of Figs. 1 and 2 show the principal component units and governing dimensions of the tower excavator. The head tower is equipped with a 180-hp. boiler, a 250-hp. main engine and a 50-hp. track engine. A 6- to 10-kw. steam-electric generating unit furnishes current for floodlights for night operations. The head tower is propelled from the main engine by a sliding-gear power takeoff through a series of spur and bevel gears and wabbler shafts to each of the four caterpillars. Steam thrust cylinders operate the friction clutches of each of the dragline and backhaul cable drums.

The tail tower requires only a 50-hp. vertical boiler for the operation of a 50-hp. propelling engine. The stump puller feature is not used, this function being per-

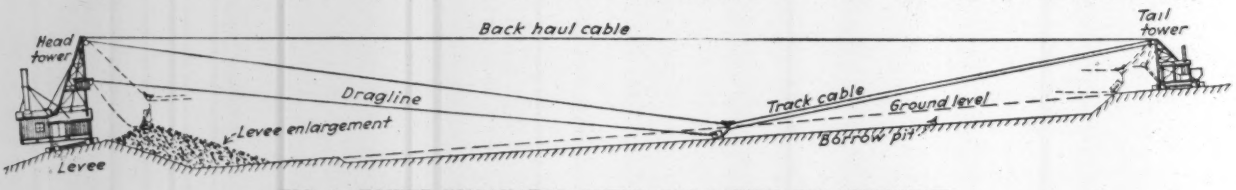


FIG. 1—TOWER-EXCAVATOR SETUP FOR LEVEE ENLARGEMENT
This machine, designed for the broad shallow borrowpit of the Memphis and Vicksburg districts, is shown fully equipped with backhaul cable. Wherever the head tower elevation makes it possible this cable is omitted and the bucket runs back by gravity.

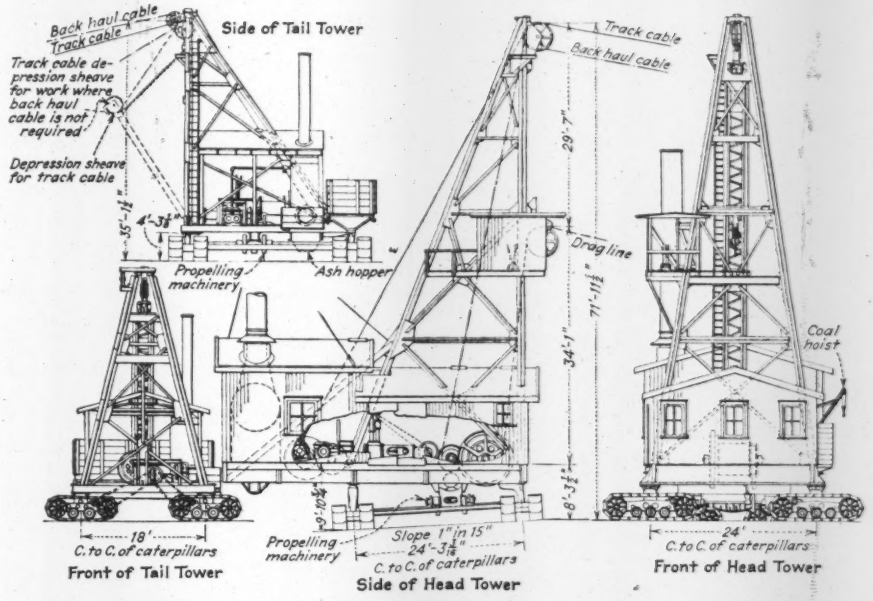


FIG. 2—TOWER DIMENSIONS AND EQUIPMENT FOR TOWER EXCAVATOR
These are the steam machines designed for the 1914-grade levee section with sloping banquette; note the crawler traction designed for travel on a sloping track.

formed preferably by auxiliary equipment. Power is transmitted from the engine to the propelling gears through a double chain drive.

Comparative elevations of head tower and farthest edge of pit, together with length of haul, will govern the possible trackline slope and determine whether gravity or mechanical backhaul is necessary. Gravity backhaul is very desirable, because it not only speeds up the return of the bucket to the pit but reduces steam consumption, since only the small trackline engine operates slowly during a gravity backhaul.

The normally used auxiliary machine is a revolving dragline with a 1½-yd. bucket and a 45- to 60-ft. boom. A stump puller consisting of a boiler, winch and A-frame-supported sheave mounted on skids is used when necessary to clear stumps from right-of-way.

The location of each of the three subprojects under discussion is shown in Fig. 3. More detailed location and topography, together with the location of campsites, are shown in Figs. 4, 5 and 8. The proximity of the work to Central Area headquarters and area supply depot in Greenville, Miss., greatly facilitated inspection and supervision as well as the rapid supply of repair parts for emergencies.

Borrowpits are always on the river side of the levee, except by special authority of the Mississippi River Commission. Riverside pits on the three subprojects under discussion required a 40-ft. natural berm to be left at the riverside toe of the levee, then a 1 on 2 slope for a depth of 3 ft., then a 1 on 50 slope for the remainder of the pit. For the Lake Port-Harwood enlargement the 40-ft. berm was not required, since the enlargement covered old narrow berm on this subproject. The starting point of the borrowpit was then determined from the estimated natural surface.

Panther Forest New Loop—This subproject (Fig. 4) involved the construction of the upper end of a new setback loop. The central portion of the loop had been constructed during 1926; overflow from Arkansas River crevasses had prevented work in 1927; the lower end of the loop was completed by contract in 1928, simultaneously with the completion of the upper end by tower excavator.

The pit area for this new loop lay in extremely low ground, as did the actual location for the levee itself. A late rise of the river cresting early in July had filled these low areas with seepage, necessitating considerable pumping and drainage and rendering the material in the borrowpits heavy and boggy. The length of the section

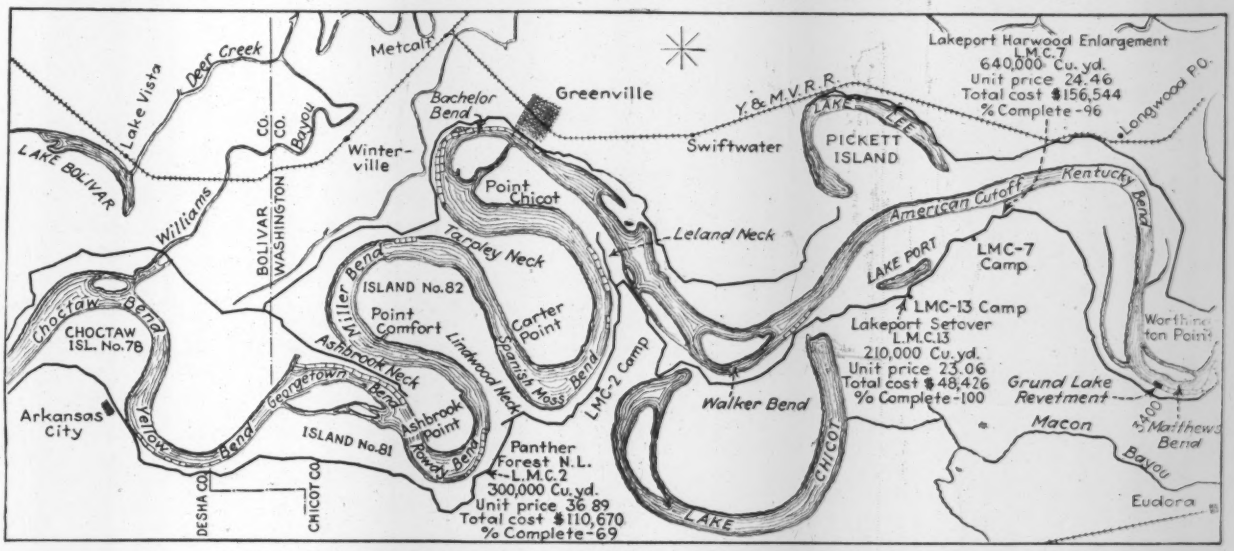


FIG. 3—LOCATION MAP OF TOWER-EXCAVATOR OPERATIONS DESCRIBED
This map shows one of the most interesting positions of the river, the series of bends and necks opposite Greenville, Miss. The lakes were formerly bends in the river. Note the complexity of levees, dikes and revetments.

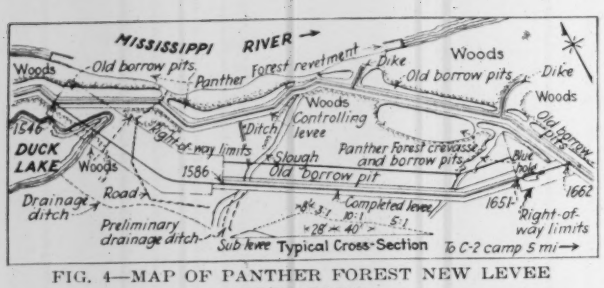


FIG. 4—MAP OF PANTHER FOREST NEW LEVEE OPERATION

This setback or new loop is particularly interesting as indicating drainage problems which may prevail and complicate borrowpit conditions.

constructed was 3,964 ft., including an actual net embankment of 319,309 cu.yd., or an average of 8,055 cu.yd. per station of 100 ft.

The pits in front of the previously completed loop section were wide and full of water and were connected with the deeply washed crevasse hole formed by the main line levee break in 1912. Before pits could be opened of area and depth sufficient for such a sizable levee it was necessary to drain out the adjacent pits to prevent seepage or direct inundation of the new pits.

The auxiliary dragline was used, Aug. 6-10, to cut a drain through the upper end of the previously completed section back to a low landside lakebed whose surface was some 15 ft. below the pit water surface. This ditch drew off all the water save from some small pockets formed by bucket traverses where minor pumping was needed.

When the ditch was completed and in operation, the dragline proceeded to cut the inspection or muck ditch, beginning Aug. 10. The material was placed within the new levee section and along the landside toe (Fig. 5*A*) forming a shelf on which to track the front caterpillars of the tower excavator. This shelf is necessary, since the machine is constructed to operate on a sloping banquette and would lean forward were the bases of both front and rear caterpillars resting on the same horizontal plane.

A minimum mobilization cost was incurred, since the machine and its auxiliaries were laid up for repairs during the previous season at the north end of the completed portion of the new loop, while the camp (at Luna) had been in place for two seasons.

The main machine began work Aug. 13. The auxiliary got well ahead with its ditching and was set out for repairs Aug. 29-Sept. 3. The tower excavator proceeded with the first lift (Fig. 5*B*) operating a single ten-hour shift, Aug. 13-Sept. 6, and two ten-hour shifts beginning Sept. 7.

That portion of the foundation and pits which crossed the end of Duck Lake failed to drain of itself as was desired. A slight shift riverward of the center-line location was made to throw the old sublevee toward the landside toe, where it might be used to give a solid base for tracking the head tower. The dragline cut a long drainage ditch (Fig. 4), which lowered the surface of Duck Lake several feet, sufficient to drain and dry the required foundation and pit areas.

Meanwhile the tower excavator had completed the first lift to the edge of the lake (station 1558), had tracked back to the initial point and started on the second lift. The first lift required the use of mechanical backhaul. The second lift, with the head tower elevated, permitted the use of gravity backhaul. The increased yardage per hour during the latter part of October and early November (Table I) shows the increased efficiency gained.

After completing the Duck Lake drainage ditch, the dragline proceeded to cut off the top of the old front-line levee required for completing the upper end of the loop, and then started building the first lift at the northern junction of the old and new levees. This operation was started Oct. 18 and finished Nov. 12. The minimum possible height was removed from the top of the old

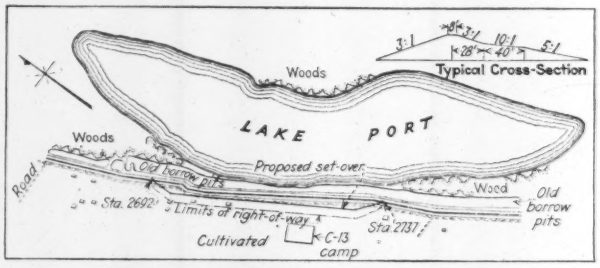


FIG. 6—LAKE PORT SET-OVER LEVEE

In this type of operation old levee provides borrow for new levee located farther back.

levee to insure against possible disaster in case of a rise in the river.

On Nov. 5 the tower excavator had completed the new loop up to station 1558 and the dragline had completed the banquette down to station 1551. On Nov. 10 a long ook up the river and an estimate of river stages revealed safe conditions for cutting the old front-line levee for a completion date of Nov. 25. The tower excavator was tracked down off the banquette and proceeded, with mechanical backhaul, to join up the first (banquette) lift; then tracked to the northern junction, and with gravity backhaul placed the final second lift. On Nov. 24 the embankment was completed.

The first rise of the season came over the cutdown section of the old levee and flooded the borrowpits Dec. 3. Dressing and sodding continued throughout the remainder of November and until Dec. 28. Final inspection and acceptance of levee were made Dec. 31, the date set for completion.

To keep up this schedule the operating crew throughout the season was about 45 men, including the foreman in general charge. Each shift on the head tower con-

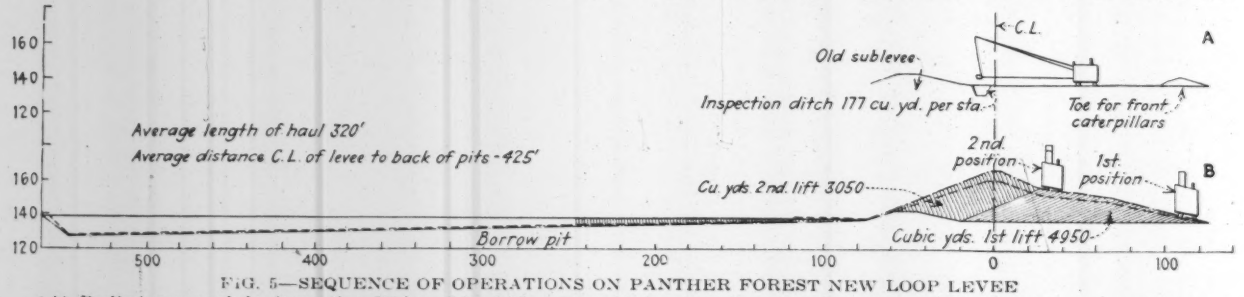


FIG. 5—SEQUENCE OF OPERATIONS ON PANTHER FOREST NEW LOOP LEVEE

(*A*) Preliminary work by inspection ditch and landside toe for frone caterpillars of tower excavator. (*B*) Construction by tower excavator: first and second positions for each lift, together with borrowpits.

TABLE I—PERFORMANCE DATA FOR TOWER EXCAVATORS ON PANTHER FOREST NEW LOOP

Month	Working Days	Lost Days, Rain or Holidays	Total, Cu. Yd.	Working Hours, Tower	Working Hours, Dragline	Tower Excavator, Length of Haul, Ft.	Tower Excavator, Cu.Yd. Per Machine-Hr.	Man-Days	Team-Days
August 16-31	15	1 (1S)	30,476	164	100	550	186	894	96
September 1-15	11	4 (2S, 2R)	32,066	141½	80	550	227	646	91
September 16-30	12	3 (3S)	37,680	196	90	550	197	761	72
October 1-15	13	2 (2S)	44,974	234	105	410	192	810	78
October 16-31	13	3 (1R, 2S)	70,824	250	115	410	283	867	84
November 1-15	11½	3½ (1½R, 2S)	64,808	211	130	375	312	743	76
November 16-24	8	1 (1S)	35,899	123	..	450	292	444	60
Final	83½	17½ (13S, 4½R)	319,309	1,320	..	425*	239*	5,065	559

*Average.

sisted of two steam enginemen, a gasoline engineman and a stoker, an oiler, a trackman and a night watchman. On the tail tower there were an operator and a stoker and on the dragline an operator, a stoker and a spotter. One spotter for the tower excavator and five dressers worked on the levee fill. For clearing there were required five laborers and an operator and a stoker on the stump puller. A general labor crew commonly known as the "bull gang" for plowing, coal hauling, sodding and procuring and hauling corduroy consisted of a foreman, three pumpmen, seven teamsters and fifteen laborers. The camp and messhouse crew consisted of thirteen persons.

The machine performance on this operation is shown by Table I. Costs are given in Table V. To indicate the causes of the delays shown, the summary for one machine has been compiled as follows:

	Hours
Head Tower:	
Backhaul cable broken	30
Trackline broken	10
Dragline broken	6
Bucket	5
Boiler	7
Steam line	2
Lubricator	2
Backhaul brake	3
Backhaul sheave	3
Water heater	1
Track engine	4
Cradle ram	6
Dirty coal	5
Tail tower:	
Broken beam	47
Ballast box framing	5
Weather:	
Rain	52
Fog	21
Total	209

When the working season is young and all machines are fresh from general repairs, the hours lost from working time are few, but as the season advances and weather conditions grow worse, troubles begin to mount. A remark from the daily report of Nov. 21 is pertient: "6½ hours delay, first one little trouble and then another: frozen pipe lines, tail tower engine valves slipped, backhaul cable broke twice."

Lake Port Set-Over—This project involved construction by the set-over method because of insufficient material between the existing levee line and Lake Port as shown by Fig. 6. As at Panther Forest, only minor mobilization costs were involved, since the tower excavator had been laid up following its previous construction just north of station 2692, together with its dragline auxiliary and stump puller. The camp had also been established for one previous season. The crews were substantially the same as at Panther Forest. Besides digging muck ditch and throwing up the landside toe for tracking the head tower, the dragline had to cut down the top of the old levee to clear the trackline and bucket. These two operations were alternated so as to keep the muck ditch and the cut-down well ahead of the progress of the tower excavator.

As will be seen from Fig. 7, the gross height of the new levee averages only 20 ft., making it possible for the tower excavator to complete the new section in one lift. Indeed, the conditions for this subproject were almost ideal for rapid and economical construction by tower excavator. The machines and camp were both on the job and good boiler water was obtainable from Lake Port. The only objectionable feature was the long fuel haul; coal was unloaded at Seven Oaks Landing and hauled by trucks under contract both for the Lake Port set-over and the Lake Port-Harwood enlargement subprojects. Table II gives the performance records and Table V the costs on the set-over operation.

Lake Port-Harwood Enlargement—On this operation, which was contiguous to the Lake Port set-over, two tower excavators (C-13 brought from the set-over work and another C-7 moved in from Mound Landing) and four draglines were employed. Therefore, unlike the other two subprojects, a heavy mobilization cost was incurred. Levee machine C-7 was moved by river from Mound Landing, Miss., where it had assisted in closing the 1927 crevasse. It was unloaded near the head of Grand Lake revetment in Matthews Bend, opposite levee station 3400 in Arkansas (Fig. 3), and was then tracked 5½ miles to station 3104, the lower end of the subproject.

Suitable campsites were few. It was decided to place the camp in the upper half of the line so that hauling of personnel and supplies to the machine would be shorter in the later stages of construction, when the possibilities of rain and bad roads became greater. Camp equip-

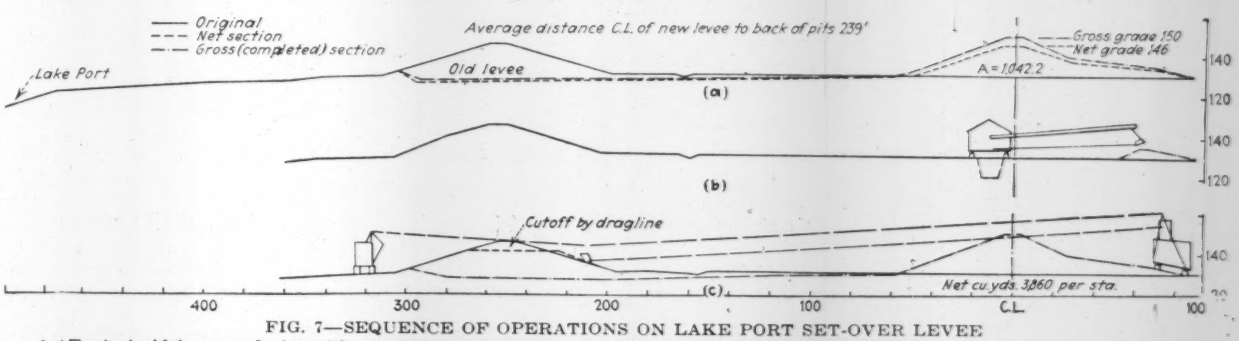


FIG. 7—SEQUENCE OF OPERATIONS ON LAKE PORT SET-OVER LEVEE

(*a*) Typical old levee and pits with proximity of Lake Port together with new gross and net sections. (*b*) Method of digging inspection ditch and placing fill for front caterpillars of tower excavator with dragline. (*c*) Portion of old levee cut down by dragline and completion of new levee in one lift by tower excavator.

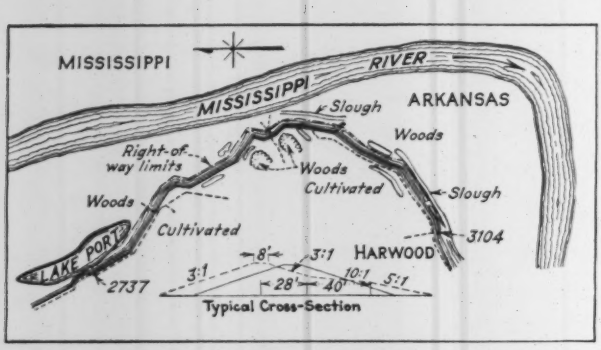


FIG. 8—LAKE PORT-HARWOOD LEVEE ENLARGEMENT
Two tower machines C-13 and C-7 were used on this operation, and procedure and performance are compared in Figs. 9 and 10 and Tables III and IV.

ment was moved from near Brunswick, Miss., and unloaded at Seven Oaks Landing; coal was unloaded at the same place.

The pits along the entire subproject were deep and narrow, and below M.R.C. specifications. The old levee, of trapezoidal section (Fig. 8) had been constructed by local interests some years before, using revolving draglines. A considerable portion of the lower end of the subproject constructed by C-7 had an old double pit (Fig. 10) where the boom machines had rehandled the material. These old pits were a constant source of difficult drainage. Moreover, in dragging material in by the tower excavator, considerable yardage was necessarily lost (Figs. 9 and 10) in the old pits. No credit was received for this yardage in the estimates.

It was found impossible for a single dragline auxiliary to keep ahead of the main machine with the heavy cutdown necessitated. One extra machine was added to each of the tower excavator set-ups, one coming from Brunswick, Miss., and the other from Mound Landing.

Of the C-7 tower excavator group, one dragline started work on cutdown and banquette construction on Aug. 28, with a single shift. This machine was double shifted Sept. 1. Tower excavator C-7 started on riverside enlargement Sept. 6, working with a single ten-hour shift throughout. The second dragline was added, worked on drainage Sept. 10-16, began cutdown Sept. 17 and worked with a single shift throughout.

When tower excavator C-13 finished the set-over at Lake Port, it continued down on the enlargement without any cessation of work, starting the enlargement Sept. 21. Its auxiliary had preceded it, starting cutdown and banquette construction on Sept. 10. An additional dragline started work Oct. 3. All the machines of this group were double shifted until Nov. 1, finishing up on single shift. Both draglines, with C-7 and one of those with C-13, finished cutdown and banquette Nov. 6, and C-7 and C-13 met at station 2900, completing their work on Nov. 9. A 60-ft. gap was left in the embankment above banquette grade, the tail towers were tracked in to the land side of the levee, and the remaining dragline of C-13 closed the gap, finishing Nov. 12. Dressing and sodding were carried on with a small force during November and December, final inspection and acceptance of the levee being made Dec. 31.

A study of comparative performance data on the work of C-7 and C-13 as shown by Tables III and IV is of interest. Tower excavator C-7 operated with a single ten-hour daylight shift throughout; its auxiliaries performed the cutdown in tandem, one cutting and the second following up with a rehandling of material to build the banquette (Fig. 10).

Tower excavator C-13 operated two ten-hour shifts except for the last nine days; its auxiliaries each performed a full cutdown and banquette building (Fig. 9), moving along the levee line by "bounds" (not leapfrogged). Tower excavator C-13 lost more yardage in old borrowpits. Excavator C-7 worked with a heavier cut and lighter riverside enlargement than did C-13. It required three dragline shifts moving 406 cu.yd. per station on cut to keep ahead of one C-7 shift with 1,400 cu.yd. per station fill, while it required four dragline shifts moving 320 cu.yd. per station to precede two C-13 shifts with 1,660 cu.yd. per station fill.

That portion of clearing of pit right-of-way involving

TABLE II—PERFORMANCE DATA FOR TOWER EXCAVATORS ON LAKE PORT SET-OVER

Month	Working Days	Lost Days	Total, Cu.Yd.	Working Hours—Tower	Working Hours—Dragline	Tower Excavator—Length of Haul, Ft.	Tower Excavator—Cu.Yd. Per Machine-Hr.	Man-Days	Team-Days
August 11-15	4	1 (1S)	4,008	10	30	275	305	236	24
August 16-31	14	2 (2S)	63,686	195	240	250	311	1,296	131
September 1-15	14	2 (2S)	88,659	203	120	230	406	1,315	118
September 16-20	4	1 (1S)	30,208	72	...	200	476	360	30
Totals	35	6 (8)	186,561	480	390	239*	375*	3,207	303

*Average.

TABLE III—PERFORMANCE DATA FOR TOWER EXCAVATORS ON LAKE PORT-HARWOOD ENLARGEMENT

Month	Working Days	Lost Days	Total, Cu.Yd.	Working Hours—Tower	Working Hours—Dragline 1	Working Hours—Dragline 2	Tower Excavator—Length Haul, Ft.	Tower Excavator—Cu.Yd. Per Machine-Hr.	Man-Days	Team-Days
September 10-15	6	0	5,088	0	113	...	...	...	75	12
September 16-30	12	3 (3S)	62,324	141	240	...	150	343	1,040	90
October 1-15	13	2 (2S)	85,932	204	233	163	250	378	1,345	135
October 16-31	14	2 (2S)	111,019	268	255	250	250	352	1,531	144
November 1-12	10	2 (2S)	37,313	80	70	90	250	416	1,075	155
Totals	55	9 (9S)	305,676	693	911	503	225	372	5,066	496

TABLE IV—PERFORMANCE DATA FOR TOWER EXCAVATORS ON LAKE PORT-HARWOOD ENLARGEMENT

Month	Working Days	Lost Days	Total, Cu.Yd.	Working Hours—Tower	Working Hours—Dragline 1	Working Hours—Dragline 2	Tower Excavator—Length Haul, Ft.	Tower Excavator—Cu.Yd. Per Machine-Hr.	Man-Days	Team-Days
August 28-31	4	0	1,729	0	40	0	...	...	32	8
September 1-15	13	2 (2S)	58,368	90	250	...	260	494	1,031	122
September 16-30	12	3 (3S)	86,362	109	240	116	270	557	1,270	192
October 1-15	13	2 (2S)	92,830	111	187	130	240	673	1,308	208
October 16-31	14	2 (2S)	99,040	126	148	148	270	617	1,380	224
November 1-9	8	1 (1S)	50,573	62	46	50	265	636	813	96
Totals	64	10 (10S)	388,900	498	911	444	261*	591*	4,834	850

*Average.

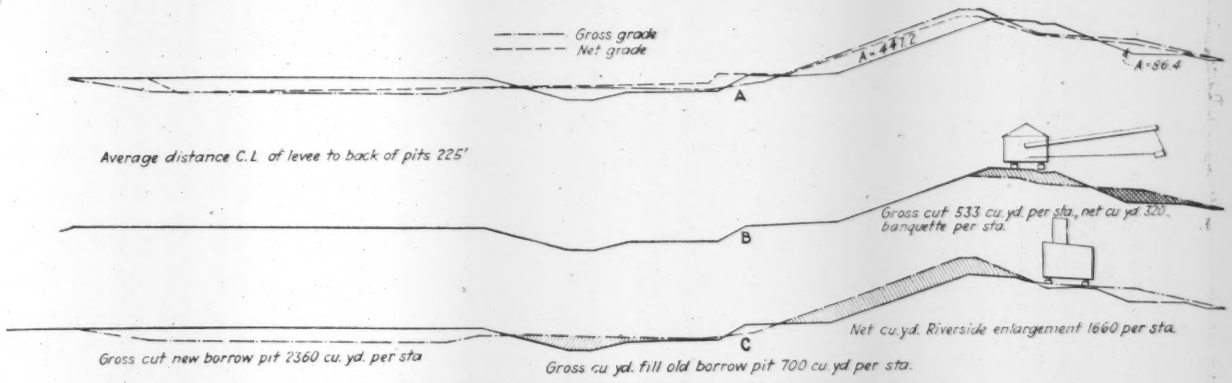

Gross grade
Net grade
A-447.2
A-86.4
A
Average distance C.L. of levee to back of pits 225'
Gross cut 533 cu. yd. per sta., net cu. yd. 320 banquette per sta.
B
Net cu. yd. Riverside enlargement 1660 per sta.
C
Gross cut new borrow pit 2360 cu. yd. per sta
Gross cu. yd. fill old borrow pit 700 cu. yd per sta.

FIG. 9—OPERATING SEQUENCE FOR TOWER EXCAVATOR C-13

(A) Typical old levee and pits with new enlargement. (B) Method of cutdown by dragline (two machines at intervals along levee, each machine completing cutdown on its portion.) (C) Enlargement by tower excavator, including yardage lost in old deep borrowpit.

cutting down and removal of underbrush and trees was performed by contract. This was let at $47.35 per acre; the total acreage cleared was 235.87 at a cost of $11,168.44. Grubbing and removal of stumps was performed by United States personnel.

TABLE V—COST SUMMARY OF FOUR TOWER EXCAVATOR OPERATIONS IN VICKSBURG DISTRICT

Subproject	Machine	Total Cost	Total Cu.Yd.	Unit Cost, Cents Per Cu.Yd.
Panther Forest new loop	C-2	$78,528.31	319,309	24.59
Lake Port set-over	C-13	30,722.30	186,561	16.47
Lake Port-Harwood enlargement	C-7	98,642.25	388,900	25.36
	C-13	64,923.47	305,676	21.24
	Combined	$163,565.72	694,576	23.55

The organization followed the same setup as outlined under the Panther Forest subproject, except for larger "bull gangs" necessitated by heavier clearing, longer water-supply pipe lines for machines, faster moving along the job requiring more corduroy, long coal haul, etc. Excavator C-13, one of the newer and more strongly constructed machines, was very little troubled by breakdowns, but C-7 had seen hard usage in closing Mound Landing crevasse and suffered more delays because of machine trouble. The teams used by C-13 unit were hired, while those with C-7 were United States owned and are the last remaining United States mule teams. It has been found cheaper to hire teams by contract for the working seasons than to purchase them and feed and care for them the year round.

Cost Summary

In hired labor work daily cost reports are submitted by each levee machine foreman showing total costs of labor (gross pay) and quantities and costs of materials used for that day. These reports also carry running totals for the month, on both costs and yardage estimates. The cost totals show a distribution over the various construction items of the work. This distribution is further carried out on the daily report over the "clearing accounts," which includes field supervision and inspection, mess and camp expense (wages of cooks, waiters, etc., and cost of subsistence supplies, camp coal, repairs to camp), corral and motor expense. A summary of the cost of each of the subprojects herein described is shown in Table V. Plant rentals for the major items of plant (including motor vehicles) are included in these costs.

Camp Operation and Equipment Upkeep

The subsistence and quarters deductions, made up of the amounts deducted from the pay personnel for subsistence and quarters furnished in kind in United States camps, are fixed by approved paytables. They vary, according to the rate of pay of the individuals, from $1 to $1.67 per day.

The Vicksburg District aims to return to its employees full value for deductions so made. Accordingly, there is insisted upon a high degree of cleanliness, sanitation and comfort in quarters furnished, and quality and variety as well as careful preparation in food provided. A ration allowance of 65c. per man per day for foodstuffs alone is maintained. Tent-houses, with elevated wooden floors, screened, and heated with stoves in winter are provided. A portable wooden messhall, floored, is situated in the middle of each camp, and separates the white and colored ends of the camp, as is customary in states in this locality. One tent serves for office. The foreman in charge is furnished a double-length tent-house. All camps are electrically lighted. Water, either from deep wells or hauled in from reliable sources, is periodically tested, and when necessary, is boiled. Employees are furnished individual iron beds with springs, mattresses and blankets. Sheets, pillowcases, towels, and

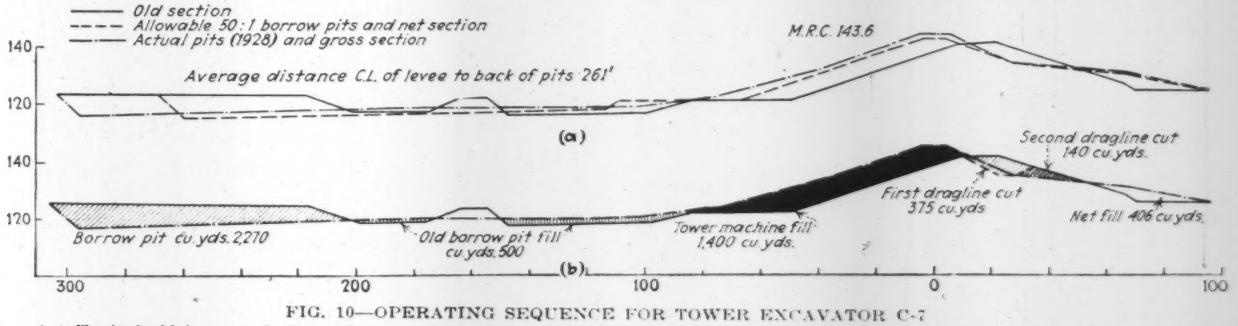


FIG. 10—OPERATING SEQUENCE FOR TOWER EXCAVATOR C-7

(a) Typical old levee and pits with new enlargement. (b) Method of cutdown and portion enlarged by tower excavator; also yardage lost in old deep pits.

table linen are provided and laundered for the higher paid employees at the expense of the United States.

Frequent inspections are made by the district engineer, the area engineer and the district medical inspector to assure that all installations are maintained in a first-class state of repair and sanitation.

In like manner all machines and auxiliary equipment in the district are maintained in first-rate order, both mechancially and in general trimness of appearance. On Sundays during the working season all boilers are washed out, repairs and adjustments are made, and all machinery is thoroughly cleaned and greased. The cleaning and greasing process is continuous during all hours of the working season.

Conclusion

The above-described subprojects mark almost the last of this type of construction to be performed. It has been found, however, that the tower excavator, even in its present form, is well adapted to enlargement to the new 1928 tentative section and grade.

Improvements to existing or possibly new tower machines are being studied. The Memphis Engineer District has successfully increased the tower height by 25 ft. at a moderate cost. Even greater increases in tower height appear feasible, by merely rebuilding the old towers on present machines.

Changing from coal to oil burning is under consideration, as well as to natural gas in some locations, but the full step from steam to diesel, electric or diesel-electric drive would remove the troublesome water-supply difficulties: long pipelines, gasoline-driven pumps, freezing, etc., as well as the coal-handling problem.

The three projects herein described were performed under the immediate direction of C. B. Allen, general foreman. The foremen in charge were: C-2, J. E. Morgan; C-13, John J. McCoy; C-7, W. S. Davis.

Refuse Dumps Supplement Trickling Filters

Twenty acres of the refuse dumps of Chester, England, are to be used to supplement the trickling filters of the local sewage-works. The filters, according to a brief note in London *Municipal Engineering* of Feb. 12, 1930, became overworked some time ago. After small-scale experiments, several acres of the refuse "tip" or dump were laid out for "secondary treatment" of a part of the sewage (presumably settling tank effluent). A project for extending the supplementary area to twenty acres is before the Ministry of Health for approval. The refuse dump is along the River Dee, where low land has been filled with refuse and covered with "soil." The land before being filled in with refuse was "composed of a shallow layer of sandy vegetable soil overlying sand and gravel," the groundwater level having been 4 ft. below the original surface.

Vehicular Traffic to and From Manhattan

Figures compiled by the Port of New York Authority reveal that during the year 1929 a total of approximately 185,000,000 vehicles entered and departed from Manhattan Island. This represents a daily two-way traffic of approximately 500,000 vehicles. All of this traffic was handled by 45 vehicular traffic facilities around the island, consisting of 22 ferries, 12 bridges and the Holland tunnel. The volume of traffic increased 14.7 per cent over that reported during 1928.

Adding Stories to a Steel-Frame Chicago Bank Building

Tall Unbraced Columns Strengthened — Girders and Cantilevers in Framing—Condition of Steel and Foundations

By Max Rosner
Consulting Structural Engineer, Chicago

PRACTICALLY doubling the floor area of a building when no such provision had been made originally was accomplished by the recent additions and alterations to the Northern Trust Company's building in Chicago. The original building was erected in 1905 for the exclusive occupancy of the company. It is about 72x190 ft. in plan, four stories high, of steel-frame construction with tile arch floors, and is supported on concrete piers sunk to bedrock. In the middle was a light court about 27x95 ft. extending above the fourth floor, with skylight at that level.

The alterations and additions involved many interesting problems and necessitated important and difficult

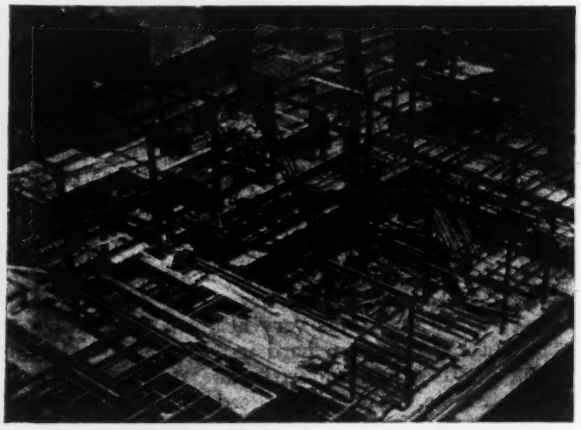


FIG. 1—ADDING NEW STORIES TO CHICAGO BANK

structural changes. The additions include two new stories over the entire area, with a large penthouse extending two stories above the roof. As the old roof has been rebuilt to form the fifth floor, the building is now six stories high. The structural alterations included the reinforcing of columns, replacing the light court with extensions of the floors, altering floor framing, converting the old roof into the fifth floor, adding several portions of floor to the interior of the building, providing a new safety-deposit vault in the sub-basement and excavating elevator pits 10 ft. below the sub-basement floor to provide for new high-speed electric elevators. The new heights from floor to floor are 15 ft. 8 in. for the fifth story and 13 ft. for the sixth story. A general view of the work in progress is shown in Fig. 1.

Strengthening Columns—On investigating the strength and carrying capacity of the present columns, it was found that some of these were able to carry the necessary increased load, whereas others would have been overstressed; therefore various means of rearranging and reducing loads were adopted. For instance, the third and fourth floors were designed originally for a live load of 100 lb. per square foot, and this was changed to 50 lb.,

the allowable live load for office floors. With the addition of the new floors, the allowable live-load column reductions helped to reduce the load on the lower floor columns. Instead of cinder concrete floor fill weighing 90 lb. per cubic foot, a 50-lb. porous lightweight concrete was used throughout, thus reducing the dead load. The old roof, or new fifth floor, had an average of 12 in. of cinder-concrete fill, with 1-in. tile roofing on top. All this tile and cinder fill was removed and replaced with the lightweight concrete.

With these and other local reductions, most of the columns were found satisfactory for the new conditions. Some columns were still weak and had to be reinforced, particularly those in the first and second stories, where unusual unsupported lengths of 18 and 28 ft. occurred in the lofty banking room. To strengthen these columns, it was necessary either to increase the area or to increase the allowable stresses by increasing the radius of gyration or reducing the unsupported length. Filling and jacketing with reinforced concrete proved to be

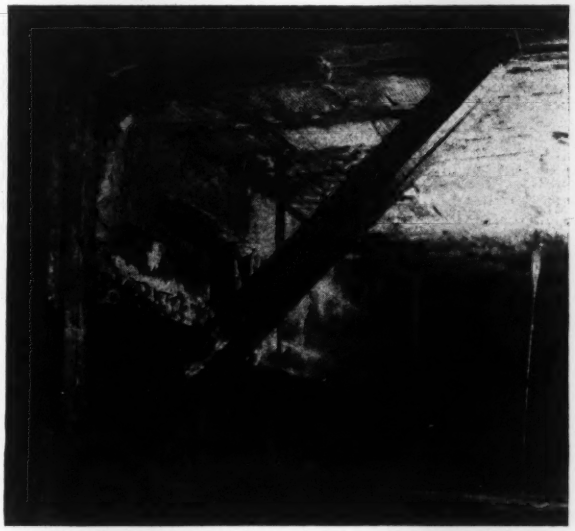


FIG. 2—BRACKETS REDUCE UNBRACED LENGTH OF COLUMNS

unsatisfactory, because it required removing and replacing a great amount of marble architecture, since pouring concrete back of the marble meant possible staining and cracking. An exception was made, however, for column 36 (mentioned below), which was strengthened with reinforced concrete from the second floor to the basement.

On account of the architectural features, it was impossible to increase the area of the columns, so the scheme of shortening their unsupported lengths had to be adopted. Two of the columns in particular, columns 36 and 37, which were 27 ft. 6 in. long in the second story and 15 ft. 6 in. in the first story, needed careful attention. It was found possible to increase the allowable stresses 30 per cent by simply cutting the unsupported length in two. This was done by bracing the columns at the middle point with struts and diagonal bracing. Between the first and second floors, where the columns were 18 ft. long, the unsupported length was reduced 6 ft. by reinforcing with 6-ft. brackets composed of pairs of angles riveted to connection plates on the column and beam or girder, as shown in Fig. 2. Many of the

FIG. 3—COLUMN CONNECTION AND SPLICE
At left, projecting end of new floorbeam anchored to wall girder to convert eccentric to concentric load on column. At right, side splice plates transmit entire load on new column (above) to old column (below).

basement columns were incased originally in 3-ft. concrete piers. Advantage was taken of this by increasing the allowable stresses.

Cantilevers and Girders—In some cases it was found more economical and practical to replace the old column with a new one than to reinforce the old one. The west or rear wall was carried on girders connected 1 ft. eccentrically on the weak axis of the columns. To relieve the stresses due to this eccentricity, the new beams at the fifth floor were extended beyond the columns. The old wall girders, which were below the ends of these

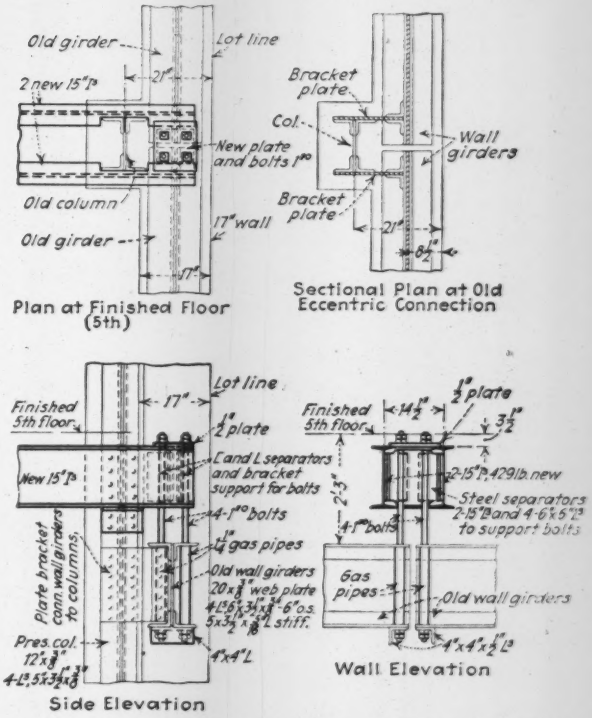


FIG. 4—NEW CONNECTION ELIMINATES ECCENTRIC COLUMN LOAD

TESTS OF CONCRETE FROM FOUNDATION PIERS

Size of Specimen, In.	Breaking Surface, In.	Breaking Surface, Sq.In.	Total Load, Lb.	Load Per Sq.In., Lb.
2½x3x4½	2½x3	7.500	25,700	3,426
1½x4x3½	1½x4	5.000	24,200	4,840
1½x4½x3	1½x4½	6.375	28,950	4,541
2x4x5	2x4	8.000	30,100	3,763

beams, were connected to these cantilever ends by bolts as shown in Figs. 3 and 4. The bolts were then tightened until the load was relieved from the bracket connections and brought back concentrically to the columns through the new beams.

At the third floor a 5-ft. plate girder spans 48 ft. between columns (31 and 34), and carries two intermediate columns (32 and 33) at its third points. It was found on careful investigation that this girder was not of sufficient strength to carry these columns with the new added loads. To overcome this difficulty a new girder had to be introduced at the seventh floor between columns 31 and 34 to carry the upper columns and framing. This girder is shown in Fig. 5. With this arrangement only one floor load, the sixth, was added to columns 32 and 33, and the girder was capable of carrying this additional load.

Splicing New to Old Columns—Particular attention was paid to column splices, since the present roof columns were not milled. In many cases the original beams extend over the tops of these columns. Thus, in splicing the new to old columns, the new load had to be transmitted through the splice rivets, and the splice also connected to the beams by slotted holes, giving it a stiffening effect without adding load to the beams. Such a case is shown in Figs. 3 and 6, representing a column splice in the west wall at the fifth floor, or old roof level. Some of the old columns are of the Gray type, built up of eight and twelve angles, and many of the new columns had to be designed with a view to the splicing with these old sections.

Condition of Concrete Piers—In constructing the new vault in the sub-basement, it was necessary to cut holes in the foundation piers to seat and carry the new vault girders. All concrete breaking was done by hand, and the holes were refilled with concrete after the girders were in place. Since the concrete here was 24 years old, was about 30 ft. below the street surface and was to have additional loads applied through the columns, it was thought best to submit samples of this concrete to tests. It was found that the concrete as exposed was

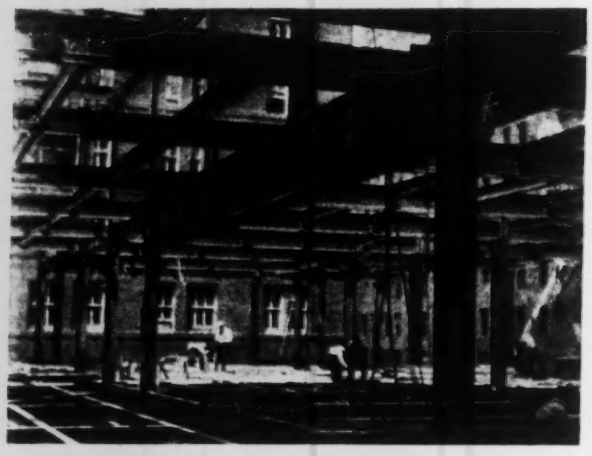


FIG. 5—PLATE GIRDER IN SEVENTH FLOOR
Girder of 48-ft. span supports two intermediate columns.

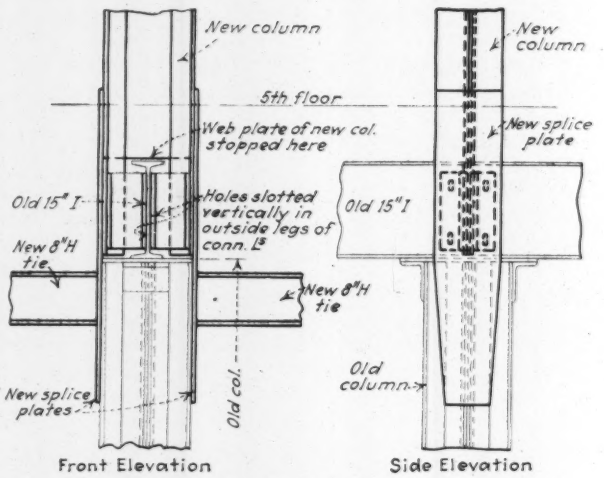


FIG. 6—COLUMN SPLICE CARIES ENTIRE LOAD
New column straddles I-beam seated on top of old column, but does not rest on latter, all load being transmitted through rivets of splice plate.

in good condition, with no porosity, despite its age and depth below the surface. Tests made by the Wilson Testing Laboratories gave results as shown in the accompanying table.

Working Conditions—Throughout the job, working conditions were difficult. The bank remained in operation during the alterations, hence riveting inside or near the bank workers was impossible. Only on the high floors could riveting be used. This meant that either turned-bolts or night-riveting had to be resorted to. It was found cheaper to use riveting done after office hours. Wherever old steel was exposed it was found in good condition, with the paint on it still good, despite the age.

Designers and Contractors—This remodeling was planned by Frost & Henderson, architects. The writer, as structural engineer, designed the new framing, alterations and reinforcement and supervised all the steel construction work and alterations. A general contract was let to Bulley & Andrews, and the steel erection was handled by the Overland Construction Co.

Progress in Inspecting Cement-Testing Laboratories

Representatives of the new cement reference laboratory in the Bureau of Standards have visited approximately 70 cement-testing laboratories located chiefly in New England and the Eastern states and have made the usual tests of apparatus and comparisons of methods. These inspections have required the testing of approximately 3,000 pieces of apparatus. Inspectors are now operating in the Southern and Southwestern states. Requests for inspections of laboratories in these sections should be made immediately if an early visit is desired. It is stated that the inspection enabled numerous variations in testing methods to be eliminated. The data accumulated by the inspectors will prove of considerable value in planning a paper on the use and testing of the equipment employed in cement-testing laboratories. Copies of the pamphlet "Proposed Tolerances on Apparatus," which forms the basis for the inspections of equipment, may be secured upon request from the Cement Reference Laboratory, Bureau of Standards, Washington, D. C.

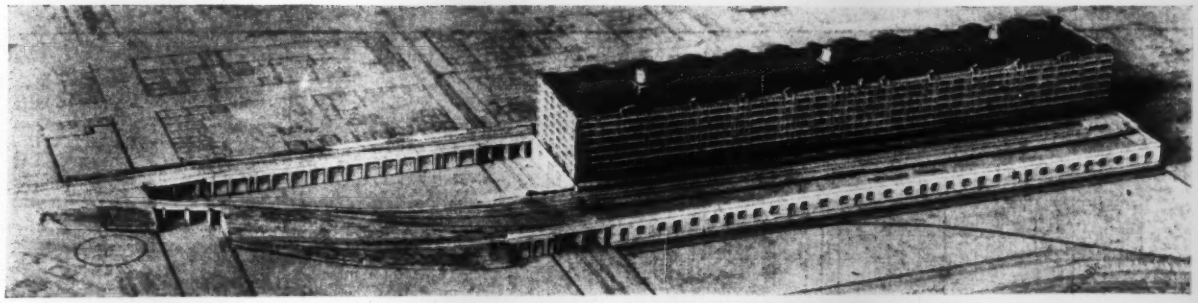


FIG. 1—MODEL OF LACKAWANNA'S FREIGHT TERMINAL WAREHOUSE AND FLAT-SLAB TRACK VIADUCTS

Design of Lackawanna's Reinforced-Concrete Freight Terminal Warehouse at Jersey City

Eight-Story Structure, 848x162 Ft., Flanked by Flat-Slab Viaducts Carrying Tracks and Truckways—Part of Extensive Terminal Development

By M. HIRSCHTHAL

Concrete Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

TO PROVIDE facilities for temporary storage of goods in transit intended for export or for future delivery into New York City, the Lackawanna Railroad is constructing an extensive freight terminal at Jersey City, including a modern eight-story reinforced-concrete warehouse, located a short distance from its Hoboken passenger terminal. The project includes extensive track revision, both siding and drill tracks, the construction of a pier on the Hudson River front, the removal of an existing engine house and the construction of a new one to replace it, and four individual bridges over streets either extensions to present bridges or at independent locations, besides the main warehouse and freight building and its immediate facilities.

The proximity of the warehouse to the New Jersey entrance of the Holland tunnel makes it available and convenient for shippers of goods destined for New York. A track from the warehouse to the new pier will facilitate the movement of goods destined for export or lighterage.

The freight terminal and warehouse include a main building 848 ft. long by 162 ft. wide, consisting of eight stories and a basement, with a three-track concrete flat-slab viaduct along the south side having a length of 1,463 ft. and another viaduct of similar design along the north side the full length of the building, accommodating five tracks and an intervening loading platform and driveway. Both viaducts are joined to the building at the second-floor level with platforms for loading to and from the building proper, while other building facilities are provided underneath the track slabs of both viaducts. Fig. 2 shows general plans and details of the terminal.

Aside from the immensity of the project, this warehouse is interesting in its design. The design problems of the warehouse building are entirely different from those encountered in the adjoining viaducts, because of the character of the loading, its intensity and amount. They have, however, this in common—they are all of the girderless flat-slab type, the building of the two-way and the track slabs of the four-way system of reinforcement. The column layout for both the building and the viaducts is on the basis of 25x25-ft. square panels, the only exceptions being the street intersections and the expansion joints, this spacing being somewhat simplified by the closing of Erie Ave. and of Seventeenth St.

Viaduct Design

South Viaduct—The viaduct on the south side accommodates three tracks 12½ ft. on centers, so that each outside track is located over the respective center line of columns. This design is unusual in that there is no continuity transversely, which continuity ordinarily would tend to reduce the moments in the slab. This, however, is compensated for in the overhang on either side. On the building side there is a platform supported by a curb wall at the edge of the track slab forming a concentration along that line. On the street side (Sixteenth St.) the edge of the track slab, which overhangs a distance of 9 ft. 9 in. beyond the center line of columns, is surmounted by an ornamental concrete balustrade. This viaduct extends beyond the present building limit at Grove St. to beyond Henderson St., and the length between Grove and Henderson Sts. on the building side is provided with a low curb wall surmounted by an iron railing so that if another unit of the warehouse is ever built along the viaduct the railing may be removed and the curb built up to the platform level.

Though all the bridges on the Lackawanna Railroad are designed for an E-65 engine loading, it was not deemed necessary to design the viaducts for the heaviest road engine loadings, as slow movements will prevail over these structures. An E-60 loading was used with an impact allowance of 25 per cent rather than the full impact derived from the usual formula:

$$I = \frac{Live\ Load}{Live\ Load + Dead\ Load} \times Live\ Load$$

The thickness of slab required for the above conditions is 24 in., with an additional thickness of 10 in. for the 10-ft. square drop-panels. The columns are 3 ft. in diameter, reinforced with vertical bars and spiral hooping.

The footing design is rather unusual. Borings had

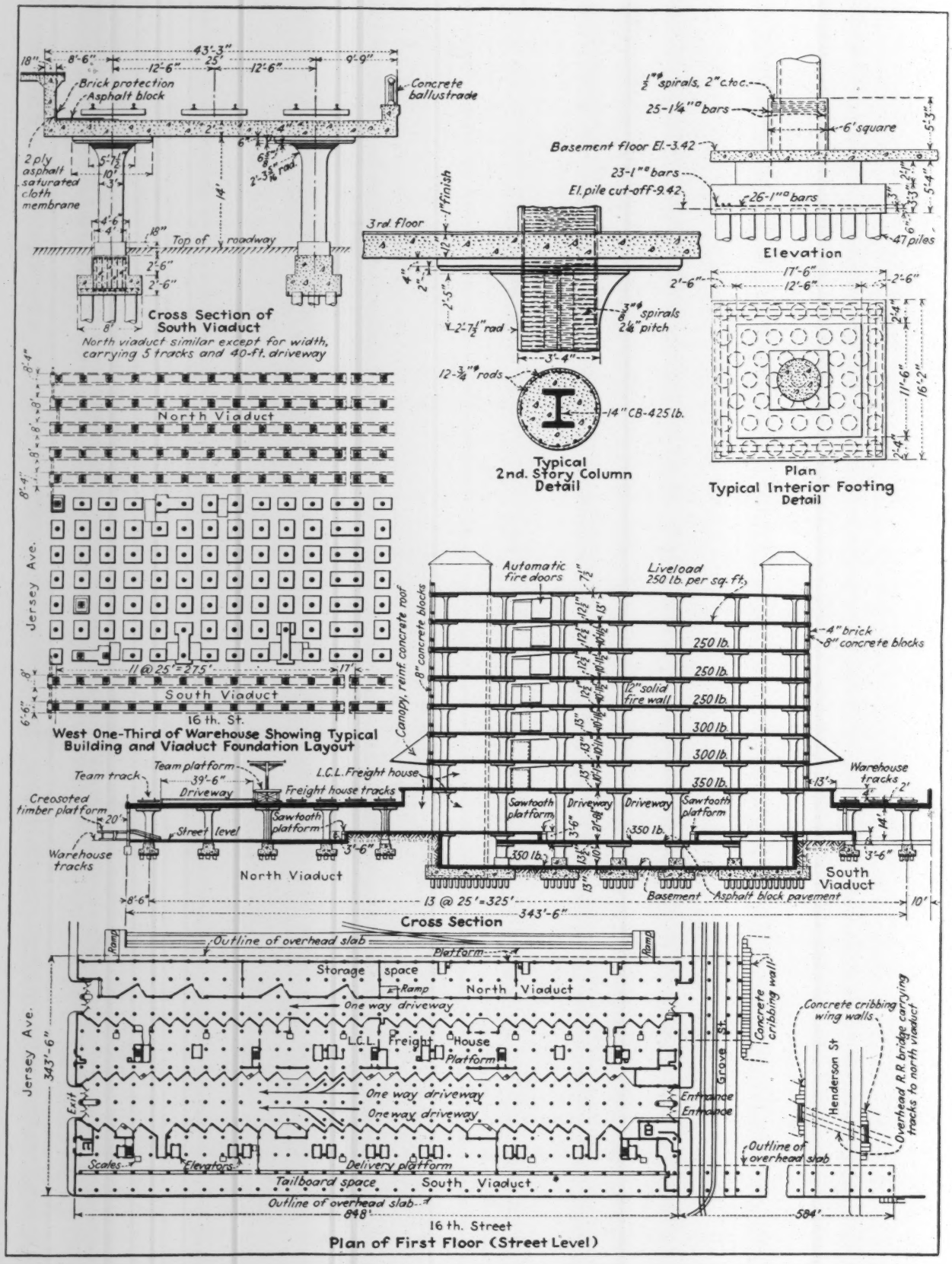


FIG. 2—GENERAL PLANS AND DETAILS OF WAREHOUSE AND VIADUCTS

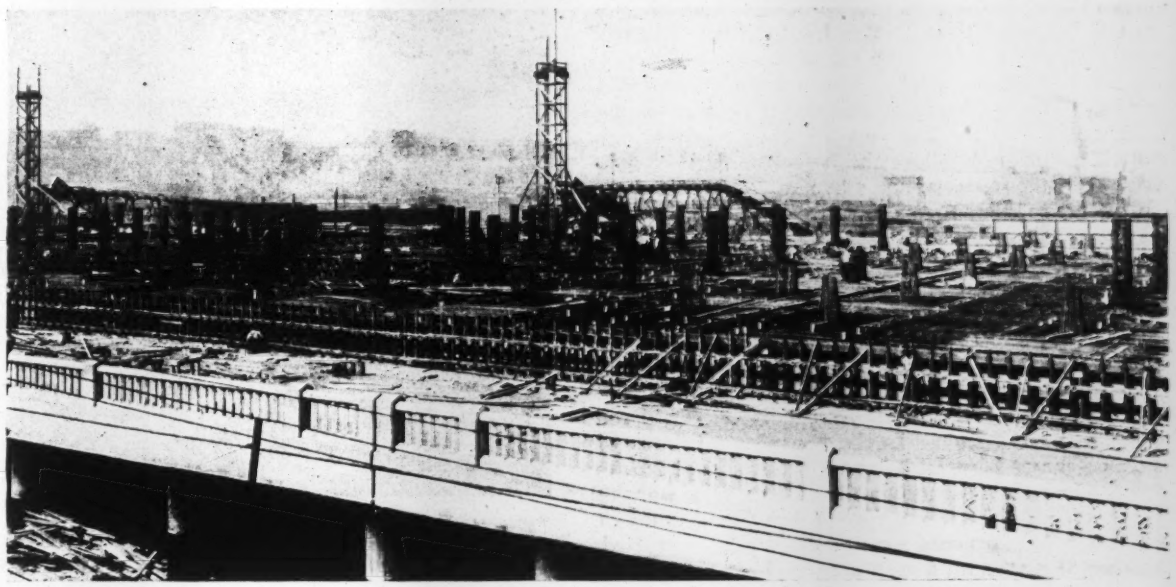


FIG. 3—SOUTH VIADUCT AND SECOND FLOOR OF WAREHOUSE
Contractor's concrete plant in background.

been taken and plotted for the entire area of the improvement. Concrete piles were selected for the foundations of the viaducts in preference to timber piles, because they permitted a higher cutoff (El. +2.5) and a narrower footing. Ordinarily such footings would be designed as individual foundations for each column, or a transverse combination for each row of two columns. But by placing a continuous footing under each longitudinal row of columns the foundation was designed for a maximum condition of loading for the full section between the expansion joints. Had individual footings or a foundation at each bent been used, each footing would have had to be designed for the maximum reaction that may be obtained at the bent. The design selected resulted in considerable economy in the number of piles required, as well as in the amount of concrete and excavation. The maximum permissible loading on the concrete piles used in the design was 30 tons per pile.

Across Grove and Henderson Sts. the footings were designed as continuous transversely, parallel to the center line of the street, because of various pipe lines encountered. At Henderson St. the pipes were placed in a concrete box hung from the footing of the columns along the street center line, the space between piles forming a pipe gallery.

North Viaduct—On the north side of the building a much wider viaduct is provided to accommodate five tracks and a driveway. The total width of this viaduct is 117½ ft., consisting of four 25-ft. panels with 8-ft. 9-in. overhangs on each side. Similar to the south viaduct there is a loading platform at the level of the second floor of the building. At the east end of the viaduct is a temporary precast concrete crib abutment to provide for future extension.

Except for width, the north viaduct is identical in design to the south viaduct, the difference in moments in the deck slab being compensated for by the amount of reinforcement provided. Because of the widths of the street for both Henderson and Grove Sts. the column centers at these crossings were made 27 ft. center to center, with an expansion joint at the sidewalk spans. The other expansion joints in the viaduct are located about 250 ft. apart to correspond to those in the main building.

The design of the track slabs was based on the methods used in this office for all girderless flat-slab bridges, the maximum positive and negative moments being found and distributed in accordance with design methods as described in the article on the Hackensack River bridge and its concrete approaches, *Engineering News-Record*, May 17, 1928, p. 779, except that the loading is as indicated above.

Both viaducts are being waterproofed with a two-ply membrane of asphalt-saturated cotton cloth laid in asphalt, protected by asphalt blocks on the horizontal surfaces and brick along vertical parapets and platform curbs. The expansion joints for these viaducts, similar to those for other Lackawanna structures, are made by completely cutting the structure at cantilevers from the adjacent columns, the opening being spanned by bent sheet copper fitted into raggles on top of the slab, raised above the slab level to shed water. The joint is then waterproofed in the same manner as the remainder of the structure.

Main Building Design

Unusually heavy live loads, considered as uniform, were used in designing the main building; 350 lb. per sq.ft. for the basement, first and second floors, 300 lb. for the third and fourth floors, and 250 lb. for the fifth, sixth, seventh and eighth floors. In addition to these loads, four columns carry the load of a 60,000-gal. water tank. Even though advantage was taken of the provision for reduction of live loads for multiple stories, permissible under the Jersey City building code (identical with that of New York City), the maximum column concentration on the basement columns is 2,750,000 lb.

Foundations—Because of the heavy column loads, the original design of the foundations called for open caissons carried down to rock. In construction, however, it was found that the steel sheeting for these caissons was difficult to drive because of boulders encountered; therefore the type of foundations was changed to individual concrete footings on concrete piles surmounted by a con-

tinuous reinforced-concrete mat over the whole area to form the basement floor. Piles for the main footings were cut off at El. —9.42, the top of the basement floor being El. —3.5. To avoid expensive excavation that would have been necessary by carrying the entire footing and pedestal below the floor surface, the pedestals were permitted to protrude above the basement floor level to provide for the tremendous punching shear resulting from the heavy column concentrations. All the foundations are reinforced in both directions, except the combined footings between the pairs of elevator shafts, which required a special design.

Columns—To carry the maximum load of the basement columns, 2,750,000 lb., required a concrete column section 4 ft. 4 in. in diameter, spirally and longitudinally reinforced with the maximum amount of reinforcement, consisting of 25 1¼-in. square bars and ¾-in. round rod hooping with 2-in. pitch. In the basement a column of this diameter was permitted, but for the stories above the ground level a maximum diameter of 3 ft. 4 in. was not to be exceeded. Therefore, for the interior columns of the first and second floors a composite column was used, consisting of a structural steel core of 14-in. H-sections with added plates where required, in a 3-ft. 4-in. concrete column additionally reinforced with spiral hooping and longitudinal rod reinforcement, all set on a steel billet to transfer the loads to the basement columns. Above the second story it was possible to use columns reinforced only with rods and spirals, the column diameters varying from 3 ft. 4 in. in the third story to 20 in. for those supporting the roof.

Walls—The basement walls are designed as reinforced-concrete retaining walls with main reinforcing running horizontally between the wall columns, which act as counterforts for the wall slab. The walls for the upper stories are brick veneer with concrete block backing, each tier being supported by the overhanging concrete floor slab. The first plan for waterproofing the basement contemplated the use of a three-ply membrane waterproofing on a concrete protection coat, but because of fear that this could not be installed under the existing water pressure, a plastic waterproofing coat was decided upon to be laid on top of the basement floor and carried up the sides of the walls and columns.

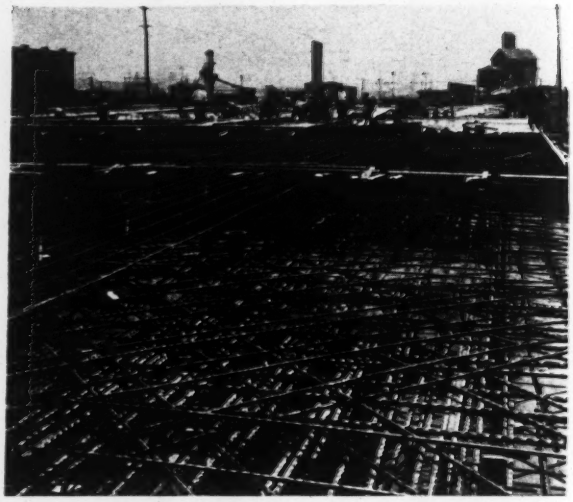


FIG. 4 — FOUR-WAY REINFORCEMENT ON NORTH VIADUCT DECK

The basement story height was fixed at 10 ft., but the height of the first story, dependent on the elevation of the loading platforms at the second-floor level, which results from the 14-ft. underclearance at Grove and Henderson Sts., is 21 ft. 5½ in. over the driveway. A feature of the building is the truck-loading platforms elevated 3½ ft. above the driveway, arranged sawtooth in plan (Fig. 2), permitting room for through traffic for trucks as well as for loading and delivery space. The height of all other stories is 11 ft. from floor to ceiling, except the top story, where the maximum height is 12½ ft.

The floor panels in the building are 25 ft. square with a 6-ft. overhang on the sides and ends of the building. There are eleven bays in each end section and ten bays in the center section separated by expansion joints at which the columns are spaced 17 ft. on centers. Transversely there are six bays.

The building is divided into six units by concrete fire walls to reduce the fire hazard, and an automatic sprinkler system is installed throughout. For the two-way flat-slab system which was adopted as the type of floor for the building, the slab thickness required for the first and second floors is 1 ft. ½ in., for the third and fourth floors 1 ft. and for the upper floors 11½ in. The drop panels were made 6 in. deep in all instances for uniformity. In the vicinity of the elevators special designs were necessary because of the concentrated loads to be carried and the break in the reinforcement bands caused by the elevator openings. This, of course, could not be designed by code coefficients, the moments and shears being computed from actual loads. In these special cases, instead of resorting to beams, the drop panels were made continuous for the panels in which the elevators occur,

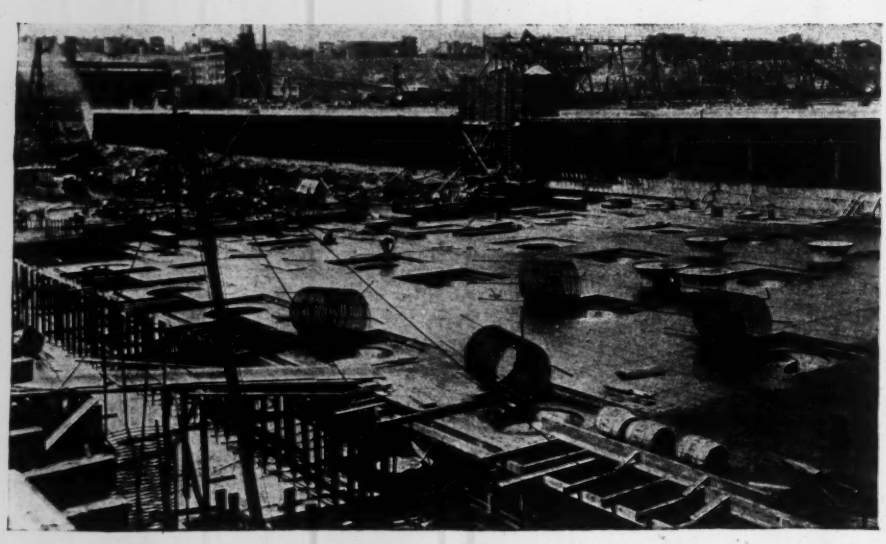


FIG. 5—GENERAL CONSTRUCTION VIEW
North viaduct and concrete plant in background. First-floor forms for building in foreground. Piledriving and foundation work at extreme left.

resulting in a total slab thickness in those sections varying from 1 ft. 6½ in. on the lower floors to 1 ft. 5½ in. on the upper floors, while a thickness of 1 ft. 6 in. was required on the roof slab because of the weight of the elevator machinery which had to be carried there. The basement floor slab was designed both for the downward live load of 350 lb. per sq.ft. and for the upward water pressure to which it would be subjected.

A total of 26 elevators is provided, distributed on both sides of the building, to be available from the main driveway platforms as well as from the outside platforms under the viaducts. Two of these are passenger elevators located at each end of the building, the remainder being freight elevators, four of which are exceptionally large, 22 ft. 1¾ in. x 9 ft. 4 in., for the accommodation of automobiles.

A notable feature of the design of this building is the fact that despite the numerous openings for elevators, stairs, ventilating shafts, ducts, etc., not a single beam projects below the ceiling level, except for the fire stop above the driveway, thus greatly simplifying the formwork.

The wearing surface of the floors throughout the building, above the basement, with the exception of the paved driveway on the first floor and the floors of the toilet rooms, consists of a patented 1-in. cement finish.

Because of the great length of the driveway through the building, it was deemed advisable to install a ventilating system, which consists of compressor fans located under the second-floor level and ventilating ducts through all the floors and the roof to carry the foul air out of the building. The main power cables, running lengthwise of the building, are carried in electric conduits in the space between the sawtooth platform and the driveway slab of the first floor. The electric power is supplied by two banks of transformers, each composed of three single-phase 150-kva. transformers located in the basement transformer vaults, while the motors for the elevators are supplied power (three phase, 60 cycles, 440 volts) by means of three single-phase transformers located on the eighth floor.

A 60,000-gal. water tank is carried above the roof, supported on four of the building columns, and will supply water for sprinkler system, sanitary service and standpipe. A 4-ft. steel smokestack 140 ft. high, incased in brick and lined with firebrick, is carried on a beam spanning between footings supporting two of the building columns. This stack is built in connection with the incinerator, which consists of two units 9x20½ ft., fed by chutes 4 ft. square, and is also connected with hot water heaters.

Fig. 6—TYPE OF CONCRETE CRIB RETAINING WALL USED TO HOLD FILLS

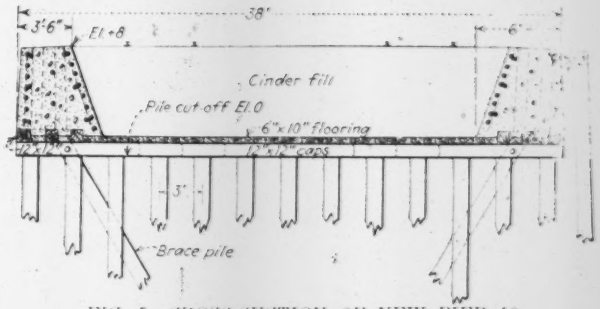


FIG. 7—CROSS-SECTION OF NEW PIER 10

The space under both the north and the south viaducts is designed for building purposes, being provided with driveways and loading platforms for vehicles, both sections being directly connected with the building proper.

Other Terminal Features—Besides the viaducts and the main building there are other features connected with the terminal and forming a part of the continuity of the whole layout that are also interesting. Among them is the pier at the riverfront, which gives the warehouse and freight terminal a direct connection with the Hudson River. This pier, known as Pier 10, is more than 1,000 ft. long, is 38 ft. wide and carries two tracks. The construction of the pier consists of wooden piles surmounted by a solid timber floor at low-water level, the sides and ends carrying heavy concrete retaining walls which hold a cinder fill carried to subgrade (Fig. 7). Base of rail elevation on this pier is El. +8, the same as that through the freight yard. The track is then carried on an ascending grade between precast concrete crib walls (Fig. 6) on a 1 per cent grade for 1,700 ft., and 500 ft. at 0.5 per cent grade to the Henderson St. bridge, reaching El. 25.50, the viaduct track level.

QUANTITIES IN ENTIRE TERMINAL IMPROVEMENT

Concrete piles in track viaducts, lin.ft.	147,000
Concrete piles in building foundations, lin.ft.	195,000
Concrete in track viaducts, cu.yd.	25,000
Concrete in building, cu.yd.	80,000
Concrete in abutments, walls and piers, cu.yd.	5,200
Reinforcing steel in track viaducts, lb.	3,700,000
Reinforcing steel in building, lb.	14,000,000
Structural steel in column cores, lb.	2,460,000
Structural steel in bridges, lb.	1,370,000
Number of units in concrete crib wall	32,500

The Henderson St. bridge is a single-track through-girder bridge supported on steel columns at the curb line and on concrete abutments at the street line, with a solid concrete deck. Three other bridges in the terminal improvement are additions to present structures, one at Grove St., one over the Erie Junction Railroad, and one at Hoboken Ave., which, because of a skew, requires 117-ft. plate girders, each weighing 70 tons. The concrete piers for this bridge, along the curb line, are of the open arch type, and because of the extreme skew and the various conditions of loading are subject to complicated stresses and are designed as hollow girders of the complete depth of pier to distribute the foundation loads.

Prior to the detailing of plans for this project a wooden model of the structure and one of the entire layout were made for the purpose of demonstrating the feasibility of the project and illustrating its various details, shown in Fig. 1.

Concrete Specifications—The specification for all the concrete on this project was based on the water cement

ratio, 2,500 lb. concrete with 6¼ gal. of total water per bag of cement for the reinforced concrete, and 2,000 lb. concrete with 6¾ gal. of water for the mass concrete. Four test specimens are made from each pour, two of which are tested at the end of 28 days, the other two at the end of 60 days. The time of mix and the amount of water are continuously watched to insure the proper resulting concrete and the test cylinders have given a uniformly good check on the quality of the concrete required.

Contractors and Personnel—The design and construction of this whole project are carried on under the general direction of G. J. Ray, chief engineer of the Lackawanna. The design is under the supervision of J. L. Vogel, bridge engineer, and the writer, while the construction is under the general supervision of M. H. Doughty, division engineer, with W. L. Lozier as resident engineer. The architectural work is under the supervision of D. T. Mack, architect of the railroad company.

The Turner Construction Co., New York, is general contractor on the viaducts, bridges and warehouse. The Raymond Concrete Pile Co. was subcontractor on the foundation work. The concrete crib retaining walls, grading and trackwork are being handled by railroad forces.

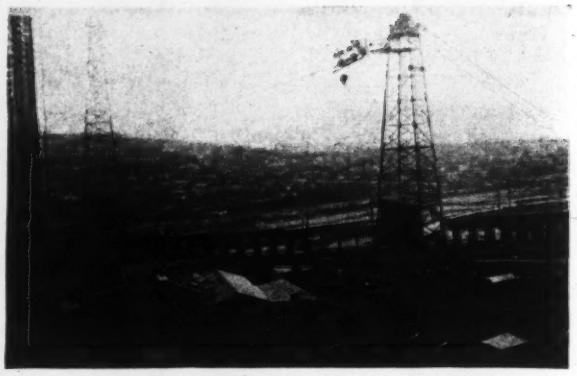
Method of Constructing Long Viaduct of Concrete Arches

By Merrill Butler and A. L. Enger
Engineer of Bridges and Structures and Project Engineer, Bureau of Engineering, Los Angeles, Calif.

FEATURING a system for distributing concrete consisting of two high-line cableways supported on steel oil-well derricks, construction work on the Glendale-Hyperion viaduct in Los Angeles required the pouring of 34,000 cu.yd. of concrete and the placing of about 2,500 tons of reinforcing steel in a series of 25 concrete arches. The large-size concreting plant designed to meet rigid specifications enabled the contractor to make a maximum pour of 1,155 cu.yd. in slightly less than sixteen hours. The use of the viaduct in solving a difficult traffic problem and the details of the design of the various arches were described in *Engineering News-Record*, March 20, 1930, p. 476. The concreting arrangements and the methods of construction are described in the following.

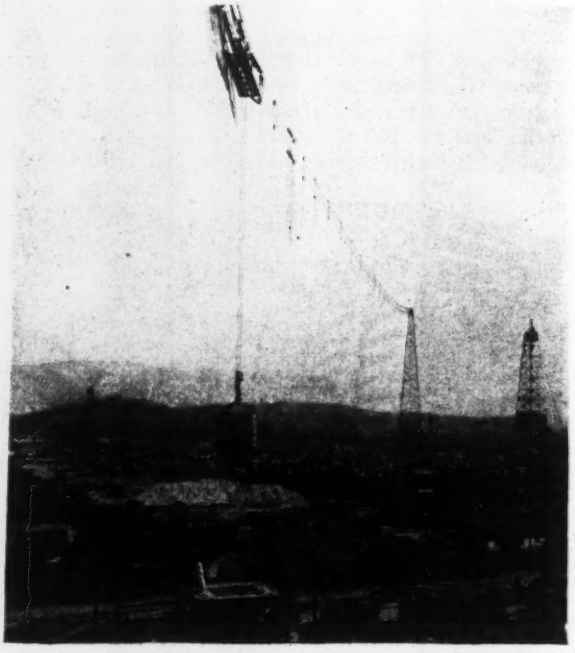
Requirements of the specifications as to size of concreting plant and type of equipment determined in a large measure the plant layout erected by the contractor. The specifications required that the capacity of the mixing plant be at least 500 cu.yd. of concrete per eight-hour day with a mixing time of 90 seconds per batch. Further specifications required that tanks be used to measure water, that sand inundators be used in measuring sand and that the three sizes of coarse aggregate be stored in separate bins.

On the subject of aggregate grading the requirements recommended an ideal percentage for the various sizes but allowed certain variations from this ideal, within limits established by means of diagrams as illustrated in the accompanying drawing. To illustrate, in the case of the fine aggregate, 72½ per cent of the fine aggregate should pass the 10-mesh sieve for an ideal grading, but variations of 60 to 85 per cent were permissible. A similar requirement was placed on the grading of the coarse aggregate after the mixing of the sizes was completed. The limits permissible for this aggregate also were presented in diagram form. A further requirement regarding handling the concrete was that after mixing it should be deposited in a deck hopper immediately before being placed in the structure and that the free fall should not be more than 10 ft.

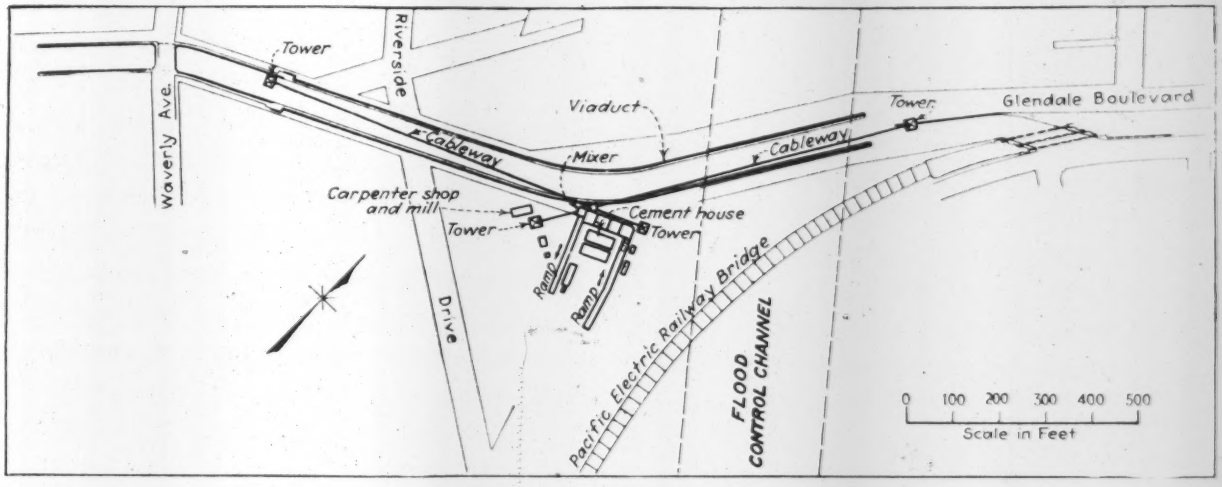


HORSESHOE-SHAPED RAMP TO BUNKERS
Concrete material dumped into bunkers for gravity feed to mixing plant.

The size and arrangement of the contractor's plant were determined by the foregoing specification requirements. A bunker system was erected midway along the viaduct and provided with a single-track, horseshoe-shaped ramp to give access to the top of the bunkers for material trucks. The combined bunker capacity of the four bins, three rock and one sand, provided aggregate enough for 250 cu.yd. of concrete. The rock bins were arranged for automatic discharge of measured quantities into a batching car that was pulled up an incline track under the outlet of each bin. Inundated sand from the sand bunker was dumped into the car by the operator of the inundator. The cement, measured by the sack, was



CABLEWAYS TRANSPORT CONCRETE TO PLACE
Cableway buckets carry concrete from mixing plant to deck hopper for buggy distribution.



LAYOUT OF CONSTRUCTION PLANT AND CABLEWAY

dumped into the car through a chute by laborers. This measured batch then was dumped into one of the two 1-yd. mixers. Exclusive of the laborers handling cement, only four men were required for the operation of the mixing plant.

The most difficult construction problem was to provide a means of transporting the concrete along the 1,300-ft. length of viaduct economically with a system flexible enough to permit concreting at different locations on short notice. The contractor's solution to this problem consisted of two high-line cableways. The high lines intersected directly over the mixing plant as shown in the accompanying drawing of the construction plant layout. The angle between the two cableways was made to coincide with the slight curve in the viaduct plan which enabled them to extend over the structure throughout its entire length.

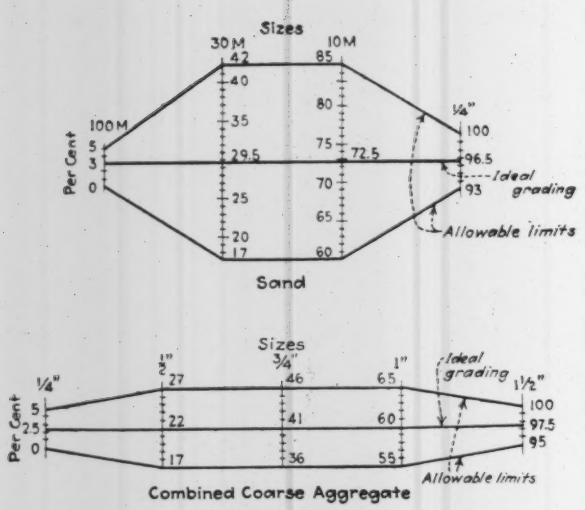
CONSTRUCTION WORK ON SPANDREL ARCHES
Note how cableway serves the viaduct line.

Support for these cableways was provided by steel oil-derrick towers; three of them were 134 ft. high and one was 185 ft. The spans were about 900 ft. and the main cables were 2¼ in. in diameter. Motive power consisted of a 200/300-hp. motor, capable of handling loads of 35,000 lb. at a traveling speed of 1,200 ft. per minute. In addition to the primary use of distributing concrete, a variety of other uses was found for this transportation system. It was in operation almost continuously, moving equipment, form lumber and reinforcing steel along the job.

This distribution system was used to transport concrete from the mixing plant to hoppers at the site of pouring. The concrete was discharged directly from the mixer into a large hopper, and this supply was used to fill a 4½-cu.yd. bucket attached to the cableways. These cableway buckets were then picked up and moved to the place of pouring, where they were emptied into hoppers on the pouring decks of the arches. From the deck hopper the concrete was discharged into buggies and placed in the forms. Deck slabs were poured directly from the buggies, but in nearly all other cases the buggies discharged through sectional pipe chutes into the forms. The entire mixing and distributing system functioned satisfactorily, delivering concrete in excess of the specification requirements with a maximum continuous pour of 1,155 cu.yd. completed in slightly less than sixteen hours. A field telephone system was installed for communication between mixing plant and point of pouring.

The large capacity of the mixing plant required by the specifications compelled pours of large yardage for economy in the mixing and pouring organizations. This in turn required the construction of substantial forms which were checked for strength and compliance with the specifications by the resident engineer. Wire form ties were not permitted and it was required that forms be held together by removable bolts or by sectional bolts that would permit the removal of the ends for a distance of 3 in. from the face of the concrete. Mortar blocks were used to support the reinforcing steel adjacent to the faces of the concrete.

Forms were required to be left in place for the follow-



METHOD OF SPECIFYING ALLOWABLE LIMITS FOR AGGREGATE GRADING

ing periods: footings, walls, columns, bottoms of slabs, 7 days; sides of beams and girders, 7 days; shores for the bottoms of girders and slabs, 28 days.

Designs for arch centers were prepared by the contractor and checked in the office of the bridge division. All centering was supported on wood piles, and in building the forms, allowance of approximately $\frac{1}{16}$ in. of settlement was made at each joint in the supporting members, in addition to allowances for deflection of joists. Besides these construction deflections allowance also was made for the deflection of the arch under dead load. The allowances as made proved too great in practically all cases, the finished arches having a slightly higher rise than designed.

Excavations for piers and abutments in or near the river channel were carried down into sand and gravel inside cofferdams built of timber and steel sheetpiling. Cast-in-place concrete piles were driven to support these piers and abutments. Difficulty was encountered in driving the piles to the required penetration of 15 ft., many of them having a bearing capacity of 80 tons, according to the *Engineering News* formula. Where foundation conditions did not require the use of piling, the piers and abutments were placed on spread footings.

To obtain neat horizontal construction joints at the end of separate pours, 2x3-in. wooden strips were nailed on the inside of the exterior forms along the top of the pour. The concrete then was brought up nearly to the top edge of each strip, and tamped carefully under the lower edge of the strip.

Construction of the ornamental handrail was carried on continuously by two crews after arch construction had advanced sufficiently. Each crew completed approximately 50 ft. of handrail per day, the usual procedure consisting of taking down the forms from the previous day's run, setting the forms up and pouring a run of 50 ft. Balusters for the handrail were cast in iron forms with a wet mix and, after curing and inspection, were placed in the forms for the base and caps of the railing. Open spaces in the railing were used for expansion joints in place of filling the space with the usual expansion joint filler. The spaces were obtained by placing gypsum plaster sheets $\frac{1}{2}$ in. thick in the forms and later removing them by sawing after the railing had set.

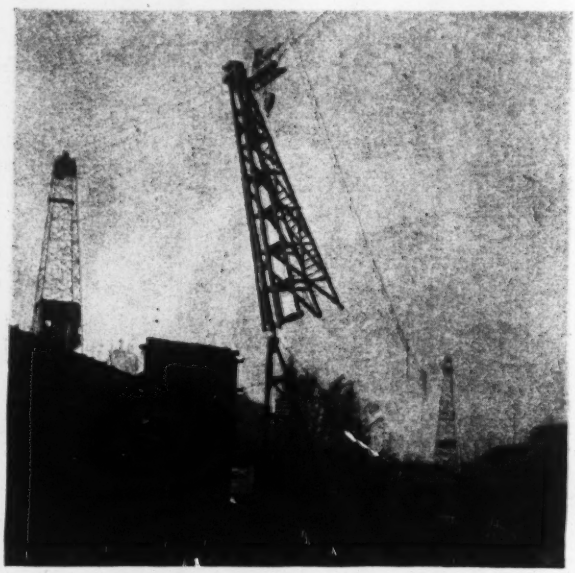
The specifications required that the handrail and other conspicuous parts of the viaduct should be given a rubbed finish while the remaining surface should have the ridges rubbed off but otherwise be left as stripped. This latter finish did not prove satisfactory in all cases, particularly because of the different color between the lower and the upper part of each individual pour. The greatest contrast occurred along horizontal construction joints, and to eliminate this condition some of the faces were painted with thin neat cement grout. After the grout had dried the surface was rubbed with burlap to give a uniform color.

STRENGTH OF VARIOUS CLASSES OF CONCRETE

Mix	Where Used	No. of Samples	Compressive Strength Lb. Per Sq.In. Aver.	Max.	Min.
1:2:3½	Case 1, footings, heavy walls, and abutments, slump less than 3 in.	31	3,258	4,300	2,250
	Case 2, deck and medium walls, slump 4 to 6 in.	66	3,489	4,900	2,400
	Case 3, columns and very thin walls, slump more than 6 in.	17	3,307	4,250	1,950
1:2½:3½	All cast-in-place ornamental work (handrail, pylons and balusters)	18	2,854	4,050	1,750
1:2:3	Concrete piles	17	4,047	5,500	2,850

The work of this contract was carried out under the supervision of the construction division of the city engineering department, with a resident engineer and assistant on the job. An inspector in charge of sampling materials was stationed at the field laboratory practically continuously and during the periods concrete was being poured, additional inspectors were used; the maximum number of the inspection force at one time was eleven men. The total cost of the project, including a minor street grade separation and a railway underpass completed before the building of the main structure, amounted to $1,607,748. Of this amount the city of Los Angeles paid $864,555, the county of Los Angeles $725,000 and the Pacific Electric Railway $18,193 as their share in the benefit of the grade-crossing elimination, which constituted one of the smaller individual contracts.

Construction work was carried out under the general direction of John C. Shaw, city engineer, and the writers as engineer of bridges and structures and project engineer, respectively. R. H. Rook was inspector of public works, H. P. Cortelyou engineer of construction and L. E. Meidroth resident engineer. The contractor was Lange & Bergstrom, Inc. A. M. Croxson was superintendent.



MOVING PILEDRIVER WITH HIGH LINE

Natural Gas to the Fore in Western Fuel Markets

Kettleman Hills Oilfield Phenomenal—Conservation Laws to Stop Gas Waste—Confidence That Supply Is Adequate for Years to Come

DISCOVERY of the enormous Kettleman Hills oilfield in California has an important bearing on the market for fuel and power in that state. The new natural gas conservation law has brought into focus the high-speed construction of large pipe lines for long-distance transmission of natural gas. Although the economics of the natural gas situation and pipe-line construction are two different subjects, both are involved in any general study of the situation as a whole. The following article considers the latter phase. In the April 10 issue there will follow an article on the construction of the latest and largest of the pipe lines—an arc-welded project 26 in. in diameter and 200 miles long. —EDITOR.

NATURAL gas as a factor in the price of fuel for heating and for industrial power was thrust rather suddenly to the fore in California during 1929 by two events—namely, exploration, which established the enormous size and the great importance of the newly discovered Kettleman Hills oilfield and the law passed by the California Legislature last August "providing for the protection of the natural resources of petroleum and gas from waste and destruction," this being "an urgency measure to take effect immediately."

A law to enforce conservation is not without precedent: Oklahoma, Texas and Kansas also have found it desirable to safeguard gas resources in this way. The Kettleman Hills field, because of its size and importance, offers a somewhat concentrated example of what unrestricted waste might mean and at the same time well illustrates the new view which the entire petroleum industry has begun to take coincident with widespread utilization of natural gas.

Conservation laws make it incumbent on the producers to find markets for natural gas if they would continue to operate the highly productive oil wells from which gas flows continuously as a byproduct. Because of the relatively low cost of delivering natural gas by pipe line and its equality or even superiority as a fuel, gas is taking the place of oil in many industrial plants. Thus, on the whole, gas has rather suddenly assumed a new importance in the oilfields.

The most immediate effect of this change has been great activity in building pipe lines through which to market natural gas. For example, the Pacific Gas & Electric Co., which serves central and northern California, last August completed a 250-mile, 20-in. gas pipe line to the San Francisco Bay region and is now co-operating in the building of another line to serve the same territory, this time a 26-in. pipe, 200 miles long. The significance to the Bay region of these two new pipe lines is apparent from the fact that prior to their con-

KETTLEMAN HILLS FIELD FROM THE AIR

struction the total consumption of artificial gas in that territory was about 65,000,000 cu.ft. daily. The two new lines will have a combined capacity of about 200,000,000 cu.ft. daily, and this can be increased 50 per cent by the use of additional compressor stations.

At the lower prices for which the natural gas can be offered it is hoped that the market heretofore served by artificial gas may be expanded enormously. In large measure this remains to be done, as does the big job of changing over all burners and gas appliances from adjustments suited to 550 B.t.u. artificial gas to that proper for about 1,170 B.t.u. natural gas.

A question very frequently asked concerning natural gas as a factor in fuel and power situations is, "What assurance is there of an enduring supply?" Perhaps the most effective answer is the confidence shown by capital—the many millions of dollars now being spent for pipe lines suitable only for transmitting gas. Within two years, and chiefly within the past year, more than 700 miles of natural gas pipe line 10 in. or over in diameter has been laid in California. The Pacific Gas & Electric Co., when it completes the construction of main and branch lines now under way, will have an investment of about $23,000,000 in natural gas pipe lines.

Even a hasty survey of conditions obtaining in the Kettleman Hills field gives much to support this confidence in the gas supply. Expert appraisals rate the field as doubling the proved oil reserves of California and its development is accepted by them as assurance not only of a long-term supply but that the price of gas and oil will be reasonable for many years to come.

The Kettleman Hills Field

The Kettleman Hills constitute a low range about 30 miles long rising above the gently sloping west side of the San Joaquin Valley half way between Los Angeles and San Francisco. The range nowhere exceeds El. 1,200 and on its westerly side is separated from the Coast Range Mountains by an arm of the San Joaquin Valley known as the Kettleman plains. Discovery of the field was made late in 1928, but the richness and extent of the find were not appreciated for some time.

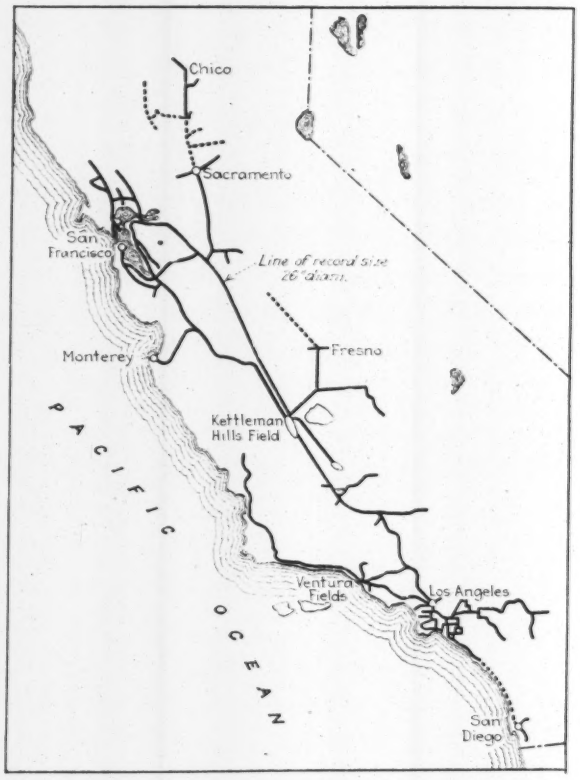
The oil-bearing strata are located in three groups designated the north, south and middle domes. Two well-known geologists, C. H. Beal and A. H. Heller, of Los Angeles, after a survey of the Kettleman field, reported that the north dome contains a proved area of 9,630 acres and that the probable acreage in the north and middle domes would total 23,910. In the wells thus far drilled the oil-bearing sand is tapped under a Bentonite cap at depths of about 7,000 ft. below the surface. Only a few wells have been driven through into the oil-bearing sand, but by the end of the year 30 or more had been put down close to the producing level and could be brought in quickly should occasion arise.

The reason there has not been a stampede to get this field into production is twofold: About 40 per cent of the land is under government control, and practically all of the remainder is in the hands of the larger oil companies. Under these conditions and because of the present state of overproduction in the petroleum industry, federal and state officials have been instrumental in effecting a shutdown agreement among the owners whereby production at Kettleman Hills has been limited to wells that were already producing when the agreement was made.

The Kettleman Hills field is now appraised as containing three times the proved gasoline reserves of all other producing areas in California combined. The nature of the deposit is well illustrated by some of the wells already brought in—for example, the Milham, the Continental and Standard Oil 8-1-P. These three wells, tapping the oil-bearing sands at depths of about 7,000 ft., have been delivering natural gas at the total rate of 250,000,000 cu.ft. daily (average for December, 1929), bringing up with this gas large quantities of oil. Initial oil production at the Milham well was 3,800 bbl. per day and at the end of a year it was still 3,200 or 3,300 bbl. This despite the fact that toward the end of the year another well some 1,200 ft. away was brought in with a steady production of 6,800 bbl. per day.

The "oil" from these wells would be described more accurately as highly volatile petroleum derivative. It is half again as rich as the gasoline used in automobiles and is put through a dilution instead of an enriching process to reach the commercial gasoline grade. This high-quality product reaches the surface under the highest pressures thus far known in California fields. Pressures at the well top, with valves open enough to permit an oil flow of 4,000 bbl. per day, normally exceed 600 lb. per sq.in., and this pressure would rise to 2,500 lb. or more per square inch if the valves were closed.

It has not been considered safe, in fact, to shut down some of the wells which first tapped the producing sands. In these wells there is danger that the casing of ordinary thickness would be unable to withstand the great stresses that would be developed by closing the valves. If the casing gave way the well would blow out, leaving a geyser of gas in an open crater, likely to ignite itself by the heat of friction and imperil the values of all near-by holdings.



MAJOR LINES FOR TRANSMISSION OF GAS IN CALIFORNIA
Lines shown dotted are definitely projected.

As soon as the extremely high pressure of this field became known, further risks from thin casings were avoided by the use of much heavier pipe. Fittings now used on Kettleman wells are designed to withstand a pressure of 5,000 lb. per sq.in. Extreme caution is used to minimize risk of fire or blowing out.

Wells in the Kettleman Hills district are producing about 22,000 cu.ft. of gas per barrel of oil. If an assumption of 1,000 cu.ft. of gas per barrel of oil is made as the ultimate total recovery and taking the nominal figure for ultimate total production of 100,000 bbl. of oil per acre, a rough estimate of the expected oil productivity of the Kettleman field is placed by competent oil geologists at well over 2,000,000,000 bbl. Correspondingly, the estimated gas production, in cubic feet, would be 1,000 times that figure.

While the basis for these figures is believed to be conservative, it is obvious that estimates of such resources are little more than guesses. Only the drill will prove what the field actually contains. Nevertheless, even if it becomes necessary to combat salt water troubles, if the less-known parts of the field should fall below the showing thus far and if the present boundaries are too extensive, there is still ample assurance that for many years to come the Kettleman Hills field will be a factor in holding down oil and gas prices.

Other Discoveries Expected

Despite the steadily increasing consumption of oil and gasoline, the proved reserves in Western oil fields at present are several times more than ever before. The end is not yet. Other oil and gas deposits doubtless will be discovered. Thus far exploration has been for oil pools, little attention being given to the gas, which was usually wasted into the air. Now that natural gas is to be widely used, exploration may take this into account with resultant increase in gas production.

In addition to discoveries of new deposits, the history of the petroleum industry has been one of continually deepening wells with corresponding increases in available oil supply. Fields 2,000 to 4,000 ft. deep which were entirely "exhausted" after a period of production, have sprung into new life with far greater production than before when explored at the great depths which modern drilling methods make feasible.

Relative Gas and Electric Transmission Costs

The new natural gas picture is not complete without some comparison of modern gas pipe lines and electrical transmission lines. A basis for rough comparative cost estimates is given by the following figures, believed to be representative for California:

A 220,000-volt transmission line bearing two circuits, each capable of transmitting 100,000 kw., ordinarily ranges in cost from $25,000 to $30,000 per mile, including rights-of-way but without any pro rata of plant or substation costs. Such a line would suffice for a 200-mile delivery.

SOME MAJOR GAS PIPE LINES LAID IN 1928 or 1929*
(Other than lines in California)

From	To	Miles	Diameter In.
Amarillo, Tex.	Denver, Colo.	340	22
Monroe, La.	Memphis, Tenn.	212	18
Wheeler County, Tex.	Enid, Okla.	165	14
Pampa, Tex.	Ottawa, Kan.	250	20
Monroe, La.	Shreveport, La.	137	20
Monroe, La.	St. Louis, Mo.	526	16–22
Mirando, Tex.	San Antonio, Tex.	250	
Baxter Basin, Wyo.	Salt Lake City, Utah	247	14–18
Zapata County, Tex.	Monterey, Mexico	143	12¾ O.D.

*Compiled by Pacific Gas & Electric Co.

NEW GAS LINES CENTERING AT KETTLEMAN HILLS

	Length, Miles	Diameter, In.	Capacity, Million Cu.Ft. Daily
From Kettleman North			
Coast Line Divisions			
Kettleman-Panoche	39 8	22	72
Panoche-Milpitas	108 6	20	
Milpitas-San Francisco	44 7	20	
Milpitas-Richmond	43 2	20	
Valley Line Division*			
Kettleman-Tracy	142 0	22–24–26	
Tracy-Milpitas	36 0	12–22	12
Tracy-Richmond	58 3	20–22–26	
Monterey Line			
Hollister-Monterey	43 4	8–12	8
Sacramento Line			
Vernalis-Sacramento	80	16	30
From Kettleman South			
Kettleman-Fresno Divisions			
Kettleman-Lemore Jct.	27	10	
Lemore Jct.-Fresno	30	8	15
Lemore Jct.-Visalia	29	6	
Hanford-Kingsburg	14	4	
Kettleman-Taft Line			
Kettleman-Taft	60	20	60
Buttonwillow Line*			
Kettleman-Buttonwillow	52	16	50
Total	808		373

*Under construction.

A 200-mile, 26-in. pipe line to carry gas under a pressure of 450 lb. per sq.in. is estimated to cost, including right-of-way and a pro rata of the necessary intermediate compressors, about $40,000 per mile. The rate of delivery through such a line could be expected to be 5,400,000 cu.ft. of gas per hour.

Taking natural gas at 1,175 B.t.u. per cubic foot and allowing 12,000 B.t.u. per kilowatt-hour (a value obtainable in modern steam plants of high efficiency), a rough ratio is 1 kw. of continuous power for each 10 cu.ft. per hour of constant gas flow. On this basis an hourly flow of 5,400,000 cu.ft. of gas is the equivalent, in heat units, of 540,000 kw.

In other words, the cost of transmission is, roughly, half as much when delivering potential energy in the form of gas in a pipe line as when delivering electrical energy over a transmission line. To make the comparison complete, of course costs at the delivery end involved in transforming natural gas into the form of energy required must be included, as must also certain costs involved in converting the 220,000-volt energy into the form in which it will be commercially applied.

At the delivery end the electrical energy has some advantage. At the point of origin, however, the electrical system is loaded with the cost incidental to the operation of the hydro-generating plant, while the Kettleman Hills gas, already under high pressure, is not only a waste product but, under the new conservation law, is now imposing on oil producers the problem of putting it to some beneficial use.

Natural Gas Pipe Lines

The accompanying tables list some of the major gas lines recently laid. Others of greater length are now proposed. In California, now the scene of greatest pipe construction activity, lines to be completed by the end of this year will add more than 600,000 consumers to the several gas systems, bringing the total number of gas consumers in that state to about 2,000,000 with an estimated gas consumption (total of all uses, including that pumped back into wells) of about 850,000,000 cu.ft. daily. This total is just about half the combined capacity of all transmission pipe lines—an indication of the extent to which market development is needed.

The methods and equipment developed for building the long oil pipe lines, which now make a network over a large part of the United States, are almost entirely

foreign to the problems involved in gas line construction. Gas pipe diameters are larger, booster stations, which use compressors instead of pumps, are spaced 90 or 100 miles apart instead of 12 to 16 miles, and low temperatures do not affect flow.

What is the economic limit of the distance which gas can be transmitted in pipe lines? A 1,000-mile line is projected from fields of the Southwest to Chicago. In California a network of gas transmission lines already built, now building or definitely projected extends some 600 miles up and down the state from Chico on the north to San Diego on the south. Gas pipe line practice has developed a technique of its own and engineering skill has worked out improvements which have greatly enlarged and extended pipe line possibilities. Within a very short time natural gas has brought to the engineer new problems and corresponding opportunities.

160-Ton Subway Tunnel Shield Moved on One Trailer

A 160-TON subway tunnel shield 20 ft. 5 in. in diameter was jacked up a shaft 40 ft. deep loaded onto a truck trailer, moved several blocks over Brooklyn's streets and lowered 37 ft. down another shaft last week without serious trouble. The shield had driven the southbound express tunnel, 1,551 ft. long, of sec. 5B, route 109, of New York's new subway system, under Prospect Park, Brooklyn, and was taken to the surface and moved back to the starting point to drive the southbound local tunnel, which will be 1,900 ft. long. A similar shield, now finishing up the northbound express tunnel, will be moved in the same manner back to the starting point to drive the northbound local tunnel.

FIG. 1—SUBWAY TUNNEL SHIELD LOADED ON TRUCK TRAILER READY FOR MOVING
Looking at cutting edge of shield.

Before the shield was jacked up the shaft the lining-erecting mechanism was removed. These erectors are different from the type usually used on shields, consisting of a separate traveling table carrying the erector arm, both traveler and erector being operated electrically, developed for handling concrete block lining. These are

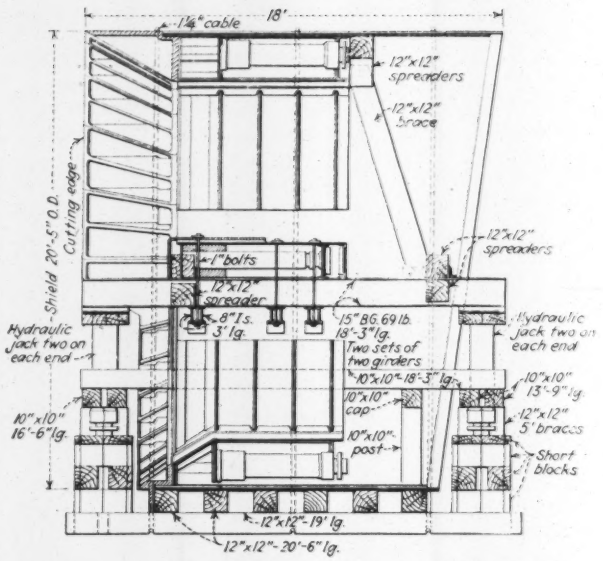


FIG. 2—LONGITUDINAL CROSS-SECTION OF SHIELD, SHOWING ARRANGEMENT OF LIFTING JACKS AND BRACING
Four jacks were used, one under each end of two pairs of 15-in. I-beams placed under the shield table. Fig. 1 shows an end view of the shield with jacks and cribbing in place.

Bracing

the first subway tunnels in New York and probably the largest anywhere to use concrete block lining.

Four of the 10-in. shoving jacks were removed from the shield and used for lifting jacks to raise the shield up the shaft. The jacks bore against two pairs of 15-in. I-beams placed longitudinally through the shield directly under the table. Timber bracing was carried from the top of the table to the inner side of the skin at the top of the shield. The lifting beams were amply sidebraced and the four lifting jacks were held in place and braced by additional framing. A cradle of 12x12-in. timbers

FIG. 3—LOWERING SHIELD ONTO TRAILER
Cables holding timber cradle in place can be noted. Cradle was framed at bottom of shaft and was lifted with shield. View shows tail end of shield.

was built under the shield before jacking up commenced, to support the load while extending the jacks and to provide a base for the load while on the trailer. The cradle was held snug to the bottom of the shield by a series of cables extending around the outside of the shield, as can be seen in Fig. 3.

Cribbing of 12x12-in. timbers was used in both shafts in raising and lowering the shield. Upon reaching the surface, a trailer of the gooseneck type, with eight wheels 20 in. wide, all under the body, was backed under the cradle and the load transferred by lowering the jacks.

A caterpillar gasoline crane assisted the truck in pulling the load. But little trouble was encountered in moving. At the start planking on a roadway leading to the street buckled and jammed up under the low body of the trailer, causing some delay. Once the load broke through the street paving of asphalt on a concrete base, requiring jacking up the load. Investigation revealed the presence of a hole under the paving at this point, washed out by a faulty sewer.

The Cornell Contracting Corp., New York, contractor on the tunnels, moved the shield, with Samuel Kent, chief engineer, in charge. W. Stuart is section engineer for the city on the work.

New York Midtown Tunnel Project —Additional Data

SUPPLEMENTING the information given in our March 13 issue on the midtown-Weehawken tunnel project at New York City being considered by the states of New Jersey and New York, additional data have been supplied by J. E. Ramsey, executive officer of the Port of New York Authority, and Ole Singstad, chief engineer of the Holland Tunnel Commissions. Under the Port Authority proposal to pool the income of the several interstate tunnels and bridges for mutual support it is not intended to use this pooled income for financing other port projects. Mr. Ramsey stated on March 12 in a letter to the governors of the two states:

> The Port Authority has at no time recommended consolidation of operations and pooling of revenues with respect to interstate crossings with the purpose that it would thereby be aided in carrying forward other projects committed to it by the Port Compact and Statutory Plan. It has expressly recommended that the pooled earnings be devoted to no other uses than to reduce debt and to lower toll rates.

He further emphasized that the proposals of the Port Authority included two suggestions: (1) That the interstate bridges and tunnels be pooled so that their revenues would operate through a revolving fund to be devoted strictly to amortization of debt and the lowering of tolls; and (2) that Port Authority credit instead of state credit be used for financing future crossings.

Dealing with the two physical plans presented (see March 13, p. 454), Mr. Singstad has made an analysis of the two cost estimates. He finds that much of the difference is due to variations in the plans themselves, the Tunnel Commissions' plan being cheaper in construction cost by about $10,000,000, even though its cost per foot is taken at a higher figure than that used in the Port Authority estimate ($1,492 against $1,375). The remaining difference is due to financing and interest charges added in the Port Authority estimate, and to cost of connection with the city's crosstown tunnel (about $3,000,000). The principal subdivisions of each estimate are compared in the table, which follows the form used by the Port Authority. It should be noted that the sum of $1,300,000, the Port Authority's estimate for rental of piers and provision of protection piers over the tunnel, has been deducted from construction costs and added to real estate costs, under which heading it appears in the corresponding Tunnel Commissions' estimate. Taking up each classification in turn, Mr. Singstad gives the following reasons for cost differences:

Construction and Equipment—Higher cost under the Port Authority's plan can be accounted for by the fact that the total length of roadway for the tunnel and approaches is 43,400 ft., as compared with 33,528 ft. in the Tunnel Commissions' plan. Total cost of construction and equipment contracts divided by the number of lineal feet of roadway in each project give a unit cost of $1,375 and $1,492 per linear foot, respectively.

Engineering and Administration—"The Tunnel Commissions' estimate is based on its past experience in the construction of the Holland tunnel and the Port Authority's estimate is no doubt based on its own experience."

Real Estate—The Port Authority's plan requires the acquisition of a greater area of real estate than does that of the Tunnel Commissions. A basis of 1930 assessed valuation plus 100 per cent was used in making the estimate of the Tunnel Commissions, while the Port Authority used 1930 assessed valuation plus 75 per cent.

Interest During Construction—The original estimate of the Tunnel Commissions made no allowance for this item, while the Port Authority included $10,230,000. Mr. Singstad states that if all the money needed for the construction of the tunnel under the commissions' plan were paid for at an interest rate of 4¼ per cent, this item would amount to $7,400,000.

Cost of Financing and Development Reserve—Here, again, the Tunnel Commissions made no allowance. The largest part of the item of $5,860,000 allowed by the Port Authority was made up of discount on proposed bonds, with an allowance of about $1,000,000 for training personnel, working capital and operating reserve. Inasmuch as the State of New Jersey sold its Holland tunnel bonds at a premium, no allowance for this item is considered necessary by the Tunnel Commissions.

COMPARISON OF COST ESTIMATES, WEEHAWKEN TUNNEL

Item	Tunnel Commissions	Port Authority
Construction and equipment	$49,915,000	$59,700,000
Contingencies	5,000,000	3,660,000
Engineering and administration	4,393,000	6,100,000
Real estate	7,620,000	9,950,000
Interest during construction	.....	10,230,000
Cost of financing and development reserve	.....	5,860,000
Total	$66,928,000	$95,500,000

Municipal Water-Softening Plants in Ohio

Completion of water-softening plants in four villages and one city in Ohio during 1929 brings the total number of municipal plants to 29, besides which three more are nearly ready to be put into operation. *Public Health News* for February states: "The public is learning the advantages of soft water and is demanding that the water delivered shall be soft enough for all domestic purposes as well as being clear and safe to drink." The bulletin predicts that "the new year will probably see the installation of even a larger number of softening plants than the past year."

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Rapid Floor Concreting in a Chicago Office Building

POURING two concrete floors complete in one eight-hour day, for the fourth and eleventh stories, was accomplished Aug. 28 in the erection of the 26-story Buckingham Building, Chicago, and this procedure has been repeated several times, the duplication being adopted for rapid progress on account of the use of reinforced-concrete floor framing in the upper stories. Steel columns and floor framing are employed up to the eleventh story; therefore the concrete is only for the slab and joist floors. But thence to the nineteenth story there are steel columns with reinforced-concrete floor framing, while above this both the columns and floor framing are of concrete. In the work above the eleventh floor, the floor girders and slabs were poured at the same time. In order to complete the structural portion of the building before freezing weather, the contractors decided to double up the floor concreting with the idea of completing three or four stories each week. Work on this

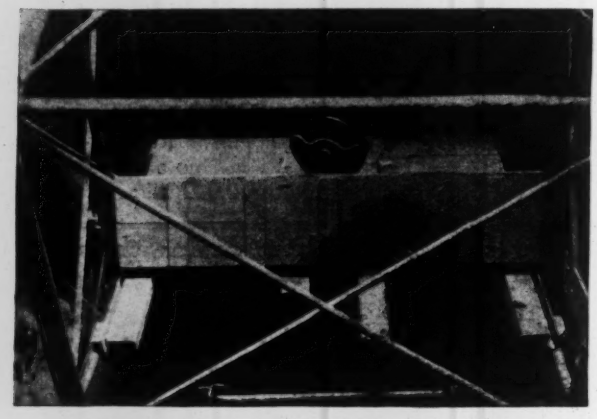


FIG. 1—CONCRETE SKIP CARRIES MATERIAL TO PLATFORM

building, 91½x112½ ft. in plan, was commenced in May, 1929, and it is to be completed early this spring.

A 1-yd. mixer in the sub-basement is served by two measuring hoppers under the sand and stone bins, of 30- and 45-cu.yd. capacity respectively. These bins are under the first floor, so that motor trucks stand over them in unloading. A combined concrete and material hoist in a tower adjacent to the mixer has a platform above the bucket, as shown in Fig. 1, and is operated at a speed of 1,200 ft. per minute by a 125-hp. motor. There is another hoisting tower for material only.

When work is organized for pouring two floors, one concreting gang of thirteen men usually pours one floor in the morning and the second in the afternoon. For this service the mixer delivers 325 cu.yd. during the day. To maintain the supply of aggregate, nine motor trucks were required, five for stone and four for sand, each making a round trip from the material yard in 40 minutes. Ordinarily, seven trucks are sufficient. The

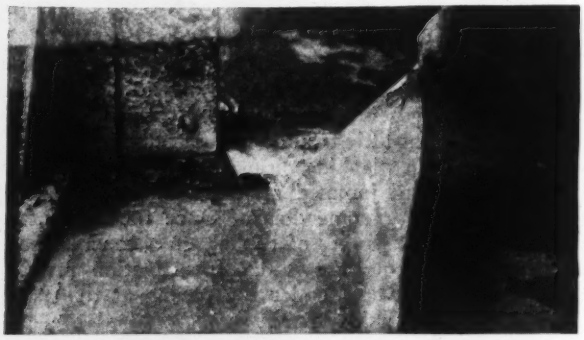


FIG. 2—PAPER COVERING PROTECTS CONCRETE SLAB

hoist bucket discharges concrete into a hopper from which it is fed to buggies wheeled over plank runways. Five floors are poured usually from one position of the hopper, the buggies delivering the concrete into pipe chutes.

For the curing period, the concrete floor was kept damp by covering it with a waterproof paper which is strengthened by sisal fiber. This paper, delivered in rolls, was spread the morning after the concrete was poured and remained in place about a week, preventing rapid evaporation of the moisture and also protecting the concrete so that the workmen could walk over the finished floor. While the cost was slightly higher than for a covering of sand, straw or shavings, the paper was considered superior for its effect in curing the concrete and protecting the concrete surface. In Fig. 2 a portion of the paper covering is pulled up to show the smooth surface of the finished slab.

The Buckingham Building was designed by Holabird & Root, architects, for whom E. R. Hawkins was superintendent of construction. The contractor was the Lundoff-Bicknell Co., with J. Davis as superintendent.

Benchmarks Established on Trees

By William Bowie

Chief, Division of Geodesy, U. S. Coast and Geodetic Survey

A RECENT report from the Survey of India contains a statement from the chief of the tree-planting division of the Forestry Branch of Canada which reads:

"In reply to the inquiry as to whether a nail driven horizontally into a tree about 3 ft. from the ground would remain at the same elevation, the answer is that there would be no change, no matter how long the tree lived. The spot would not become any farther away from the ground. The only chance of a slight difference of elevation would, perhaps, be in the case of a very small tree becoming slightly heaved up by frost; or if soil might be washed in and cause a very slight rise."

This is welcome news to engineers who are running lines of levels in areas where it may be difficult to trans-

port material for benchmarks and where there are no outcropping rocks into which marks may be set.

While many have debated the question as to whether a point on a tree remains fixed in elevation or changes its elevation with the growth of the tree, it is probable that very few tests have ever been made. It would seem evident from the above quotation that the Canadian forestry officials have made such tests, for this quotation is contained in a letter which was sent to India by the Surveyor-General of Canada. He remarked that the tree is not an ideal location for a benchmark for the reason that it is subject to destruction by forest fires. But if enough trees are used as benchmarks along a line of levels it is reasonably certain that some of them will survive forest fires for a number of years. Another difficulty involved in the use of a tree is that the nail or spike used as the mark is likely to be hidden by the accretions which add to the diameter of the tree. This is really not an extremely serious matter, for "in Canada a tree will expand radially on every side about 1 in. in twelve years between twenty and 100 years of age."

Undoubtedly the use of trees for this purpose is very satisfactory for a line of levels which is to be used for only a short time, such as the level line run ahead of a surveying party making a topographic map. On all leveling lines which will be used for many years to come, of course, the most permanent form of benchmarks should be established, and probably the best is a metal tablet properly inscribed set in outcropping bedrock.

Special Derrick Car Developed for Heavy Plate Girder Work

A COMBINATION locomotive-crane derrick car of novel design, capable of handling 100 tons at an 85-ft. radius and 20 ft. to either side, has been developed by the American Bridge Co. It has recently undergone tests successfully and will be used on a single-track viaduct about 3,500 ft. long and 200 ft. high on the new line of the Pittsburgh & West Virginia Railway Co. near Pittsburgh, the project involving girders up to 125 ft. in length.

The development of this piece of erection equipment resulted from a general tendency on the part of engineers to design plate-girder bridges longer and heavier than formerly, and followed immediately upon the completion of work on the Cleveland terminal last year which involved the erection of 300 130-ft. 100-ton girders. This work was erected with a derrick car of somewhat similar although much cruder design. Owing to the development of this modern heavy derrick car equipment, girders up to 140 ft. long are now being considered.

In the accompanying illustration the locomotive-crane derrick car is shown lifting 100-ton test load at a 75-ft. radius. A seven-drum hoisting engine is mounted on the rear of the derrick car proper. Three of the drums handle the topping lifts and the two main falls at the end of the boom, and have a lead-line pull of 60,000 lb. at 150 ft. per minute. There are two runner drums which handle 15,000 lb. on a single line at 200 ft. per minute; the lines from these drums are shown hanging from the extreme end of the boom, where they work ahead of the main falls, entirely in the clear. The remaining two drums are also runner drums which furnish auxiliary lines and general utility service. In addition they are used in steadying the car when it is necessary to run it over rough track on a new fill.

The locomotive crane at the rear of the derrick car, to which the backstays are attached, is a standard 150-ton wrecking crane. This equipment furnishes the power plant and serves as a locomotive for propelling the car. It also acts as an anchorage counterweight. The locomotive crane is equipped with three reversible drums which handle quarter falls and the swing lines. There is also an auxiliary engine line which can be used as an additional runner.

It will be noted from the illustration that an extra boom is carried on top of the backstays. This is the standard locomotive crane boom which is useful in unloading steel and which is always necessary in order to

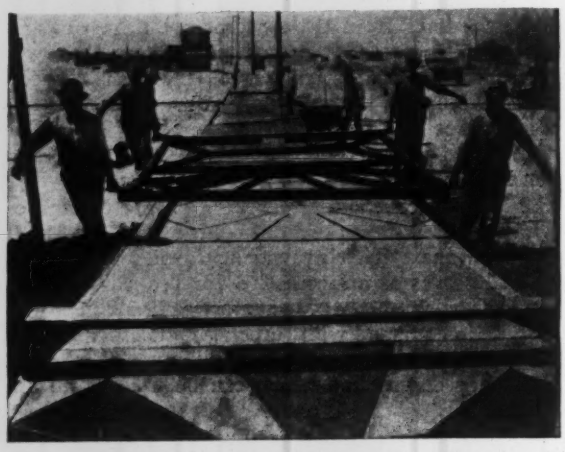
COMBINATION LOCOMOTIVE-CRANE DERRICK CAR FOR ERECTING LONG, HEAVY BRIDGE GIRDERS

set up the derrick car when the equipment arrives on a new job.

Patents have been applied for on this locomotive-crane derrick car, which was originated and designed by James L. de Vou, central district erection manager of the American Bridge Co. Richard Khuen, Jr., is general manager of erection and L. A. Paddock is vice-president in charge of operations. The seven-drum hoisting engine was built especially for this equipment by the Lidgerwood Manufacturing Co. and incorporates special air control drum frictions and drum brakes.

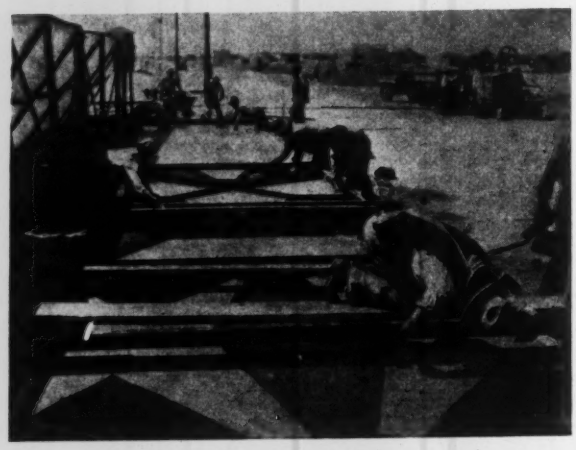
Welded Steel Forms Aid in Placing Novel Color Design on Sidewalks

TO AID in the construction of a multi-colored sidewalk, steel forms were used recently at an oceanside subdivision in Ventura County, Calif. As used, the



BRINGING DESIGN FORM TO POSITION
Form 15 ft. long and two designs provided; pattern repeated every 30 ft.

forms were built to produce elaborate designs using a great variety of colors, but the method employed is simple and could be applied with equal success for more conventional uses. The sidewalk leading from the ocean drive to the beach is 10 ft. wide. It is built on a sand subgrade with a 3½-in. base course of dry-mix concrete and a ½-in. finishing coat of 1:2 cement mortar. Colors in dry form mixed with cement were placed on this mortar coat and worked in with wood floats and steel trowels, using the steel forms to provide the design.



PLACING COLORS IN DESIGN PANELS
Color floated into mortar topping.

The forms were 10 ft. wide and built in 15-ft. sections. The frame for this form was built of 3x4-in. timbers and the design was fabricated with ⅛x3-in. strap iron using welded joints. The lower edges of the steel strips extended a little below the edge of the timber frame to cut into the mortar coat on the sidewalk and provide pockets for applying the various colors.

On this job two different design forms were used, the pattern repeating every 30 ft. Expansion joints of ⅜-in. thickness were also provided every 30 ft. Cost for 180 ft. of these forms was reported to be less than $350. The work progressed at a rate of about 2,200 sq.ft. of sidewalk per day.

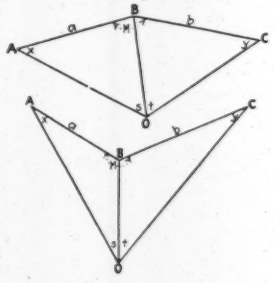
The work was done at Silver Strand Beach, Ventura County, Calif., by the Fleming Construction Co., of Pomona, Calif. Color work was done by W. J. Davis, of Los Angeles.

Solving the Three-Point Problem

By F. S. Foote
Berkeley, Calif.

THE following solution of the three-point problem of surveying, in which it is desired to calculate the position of an occupied point by measuring the angles to three points of known position, consists of using two simple equations to determine the two unknown angles by trial, after which the triangles may be solved by the sine law. This method eliminates the difficulty common to several of the well-known solutions which become indeterminate when the total angle at the occupied point equals the total angle at the middle point of the three whose position is known and, although it may not be entirely new, the method has never come to the writer's attention.

Referring to either of the two accompanying figures, there are given the positions of the three points *A*, *B* and *C*, from which can be found the distances *a* and *b* and the angle *M*. The transit is at the point *O*, the position of which is to be determined. At *O* the angles *s* and *t* are measured. If the angles *x* and *y* can be determined, the solution is possible by application of the sine law to either of the two triangles formed.



In triangle *AOB*, $BO = \frac{a \sin x}{\sin s}$. In triangle *BCO*, $BO = \frac{b \sin y}{\sin t}$. Equating and solving,

$$\frac{\sin x}{\sin y} = \frac{b \sin s}{a \sin t} \quad \ldots\ldots [1]$$

In the quadrilateral *ABCO*,

$$(x + y) = 360° - (s + t + M) \quad \ldots\ldots [2]$$

Equations 1 and 2 give direct solutions for the values of $(x + y)$ and $\frac{\sin x}{\sin y}$.

The remaining part of the solution consists in finding

by trial, values of x and y such that they shall have at once the proper sum, calculated from equation 2 and the proper ratio between the sines, calculated from equation 1. The procedure may best be shown by an example. Suppose that: $a = 1299.65$, $b = 4063.79$, $M = 224° 50' 24''$, $s = 11° 37' 59''$, $t = 71° 57' 17''$. Then: $M + s + t = 308° 25' 40''$; $(x + y) = 51° 34' 20''$.

$$\begin{aligned} \log b &= 3.6089315 \\ \operatorname{colog} a &= 6.8861814 \\ \log \sin s &= 9.3045832 \\ \operatorname{colog} \sin t &= 0.0219053 \\ \log \left(\frac{\sin x}{\sin y}\right) &= 9.8216014 \end{aligned}$$

Since this is the logarithm of approximately 0.66, take one angle about two-thirds of the other as a first approximation, or try $x = 20° 00'$, $y = 31° 34'$, neglecting the seconds temporarily.

Then

log sin 20° 00′	= 9.53405	diff. 35 per min.
log sin 31° 34′	= 9.71891	diff. 20 per min.
	9.81514	55

The difference between this logarithm and the logarithm of $\frac{\sin x}{\sin y}$ is 9.82160 — 9.81514 = 646. Dividing this by 55, the sum of the log sine differences per minute, gives 12 min. approximately, by which the assumed value of x is to be increased. Using now the more exact value of $(x + y)$—that is, 51° 34′ 20″—if x is 20° 12′ 00″, y must be 31° 22′ 20″.

log sin 20° 12′ 00″	= 9.5381943	diff. 57 per sec.
log sin 31° 22′ 20″	= 9.7165006	diff. 35 per sec.
	9.8216937	92

The difference between this and $\log \left(\frac{\sin x}{\sin y}\right)$ is 9.8216937 — 9.8216014 = 923. 923 ÷ 92 = 10″ to be subtracted from (x).

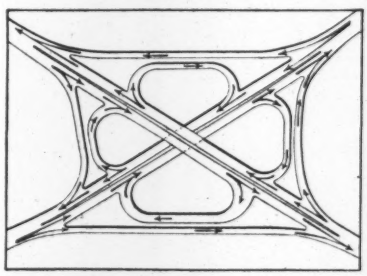
Log sin 20° 11′ 50″	= 9.5381371
Log sin 31° 22′ 30″	= 9.7165352
	9.8216019

Since this is practically equal to 9.8216014, $x = 20° 11' 50''$ and $y = 31° 22' 30''$.

The number of trial solutions necessary may sometimes be reduced by first making a graphical solution on the drawing board and scaling values of x and y for first approximation.

Job and Office Note

ILLUSTRATED HEREWITH is the plan laid out by the New Jersey State Highway Department for the intersection of two busy highways near Woodbridge, N. J. Route 4, carrying traffic from northern New Jersey to shore resorts, passes under Route 25, the main approach to the Holland vehicular tunnel from the west. To provide for the many vehicles which will desire to turn right or left at the intersection, a layout has been adopted which permits these movements without the necessity of crossing moving lines of traffic. The heavy black lines shown in the illustration are parkways separating each route into separate channels.



Letters to the Editor

Sand Blotters for Frost Boils

Sir—Chippewa County, Mich., is more or less noted for its heavy red-clay soil. This is good for agriculture, but it is not so good as a road subgrade. A fair mileage of the state trunk-line road is a 6-in. limestone macadam which has been surface treated with tar and chips.

These roads are subject to severe frost action. The center thaws out in the spring before the shoulders thaw, with the result that the road becomes a basin for holding water. The action of traffic puddles this water into the clay so that the surface of the road is often completely destroyed.

The removal of this water can be accomplished only by draining it away or drying out the clay. Draining has not been very successful in this clay; cracks from ½ to 2 in. wide, opened up by frost, have remained full of water for days and weeks. The evaporation was small. To increase it a sand blotter was placed. Bank sand was available and small dump trucks were loaded with this material and it was spread upon the spongy macadam to a depth of possibly 1½ or 2 in. The water was drawn up by the sand and spread throughout its entire width of 8 ft. or more, resulting in a vastly increased radiating surface. This surface was also dried out by wind action.

The method is almost too simple to be true, but the results are so evident that they are commented on by the traveling public most favorably. The Chippewa County Road Commission handles the state maintenance under contract.

Sault Ste. Marie, Mich. L. F. LEVIN,
March 8, 1930. County Engineer.

Differences in Refuse Disposal Practice in Europe and North America

Sir—Much has been written concerning European practice in collection and disposal of refuse, but probably little has been published of the dissimilarity of this material and that of North America and of the risk taken by American engineers in applying European data to their problems without a clear conception of the difference. Some notes on this and related matters, based on three recent trips abroad, are submitted supplementary to the articles on refuse disposal abroad published in your columns during the past six months.

The different customs in regard to house heating—that is, the foreign use of several individual grate fires instead of the American central heating plant—the greater American consumption of green corn, fruit and watermelons, the natural frugality of the European people and their lower per capita wealth, the extensive use of individual containers for food and merchandise in America and the greater number and bulk of newspapers here than abroad, all these differences are reflected in the characteristics of American and foreign refuse.

The less perfect combustion and the practice of letting grate fires go out one or more times during the 24 hours result in a larger proportion of unburned coal in ashes from grates than in those from central heaters. Where the consumption of fresh fruit and vegetables is relatively low there is a corresponding reduction in moisture in the refuse; the wasteful Americans discard many more miscellaneous household articles than the Europeans, and the much greater number of individual containers and greater volume of newspapers give American refuse an appearance much different from that of Europe.

The mixed collection of ashes, rubbish and garbage in the same vehicle is common practice in Europe, with the result that the entire mass has a relatively high calorific value and a low moisture content, and is very dusty. In fact, in England refuse is commonly called "dust," the household containers are "dust-bins" and the collectors are "dustmen."

Many incinerators in Europe are equipped with screens for the separation of the fine material, which contains enough organic matter to be of some service as a fertilizer, although

perhaps its chief agricultural value lies in the lightening effect of the ashes and fine cinders upon heavy clayey soils. It is difficult, if not impossible, to find an agricultural market for all this material.

The presence of ashes in the mixed refuse of Europe results in the production of large masses of hard clinker in the residue from incineration. This material can, if desired, be broken up, sorted by screening and used instead of gravel and sand in road foundations, in the manufacture of concrete articles such as slabs for sidewalks and curbstones—as a raw material for brick making, and for a few other purposes. The North American problem of disposal is greatly simplified and cheapened by keeping the ashes separate from combustible rubbish and garbage *in the household and continuously thereafter.*

Wage rates in England and Scotland in the summer of 1929 on refuse collection and disposal were about $2 to $2.25 for common labor and about $3 for electricians and engineers per day of eight hours.

It is rather common in Europe to utilize some of the heat in the refuse by generating electric current for use in operating the incinerator and the salvage works, and in a few cases a surplus of current is sold to the municipal electricity department or to an electric light and power company. Before an American municipality adopts the practice of generation of electricity from refuse, however, consideration should be given to such factors as the calorific value of the fuel and its moisture content; the amount of hand firing required by the peculiar nature of the foreign materials in the refuse; the current wage rates; the availability of cheap power from large central generating stations and so-called superpower circuits; the fact that in some new plants the station requirements are less than one-fifth of the output; the available demand for current and the ability to synchronize production with demand.

In this connection the following facts are significant: That in at least one incinerator in the United States, ideally situated for the utilization of surplus power, it has consistently been found to be impossible to synchronize production and demand; and when bids were received a few years ago for an incinerator at Buffalo containing alternate proposals with and without steam-generating equipment, based on detailed specifications, it was found to be cheaper to buy current from the Buffalo General Electric Co. than to generate it.

It is my opinion from my visits in 1924, 1926 and 1929 that the practice of salvage and byproduct utilization in England is decreasing.

HARRISON P. EDDY, JR.,
Metcalf & Eddy, Engineers.

Boston, Mass.,
March 10, 1930.

Aeronautics and Civil Engineering in Airport Development

Sir—Many municipalities in attacking the new problems incident to airport development have failed to recognize the proper place and need for aeronautical engineering advice. At one extreme are those cities which have placed the task of developing a suitable airport in the hands of some local pilot. On the other hand are those cities where the city engineer, from choice or necessity, has proceeded single handed without the aid of aeronautical knowledge. It would seem to be quite as necessary for airport developers to utilize aeronautical engineering knowledge as it has been for the railroads to take advantage of the knowledge of experts on transportation.

It should be self-evident that civil engineering experience is needed. A little reflection will show that aeronautical knowledge is no less indispensable. For instance, airports must anticipate aviation development, for their location, design, construction and equipment depend entirely upon the class of aircraft that will use them. With changes in aircraft design and with an increase in activities, both in number and in character, airports must also change in character and accommodations. To say that the design of an airport is simply that of arranging a large area from which planes may operate is similar to contending that the building of a dock of certain dimensions will accommodate any type of watercraft. We are constantly finding that channels must be deepened and widened, that docks must be increased in size and that additional facilities must be provided. The same applies to docking facilities for aircraft. Since this reverts back to aircraft design and the probable advance in such design, the engineering of an airport not only requires experience in the various branches of construction but must at the same time have a definite background of aviation experience and a knowledge of the development of aircraft improvements.

Another view of the situation bearing on the necessity for aeronautical advice is that airport development demands an intimate knowledge of the various activities and requirements for different types of operation in much the same manner that a private garage differs from a motorbus station or the wayside waiting room on a through railroad line differs from large metropolitan terminals. One might sum up the subject by stating that future airport designs are now resting in the cradle of the wind tunnels of our various aircraft manufacturers.

B. RUSSELL SHAW,
President B. Russell Shaw Co., Inc.,
Airport Construction Engineers.

St. Louis, Mo.
Feb. 18, 1930.

Research Data Wanted on Sliding Friction in Bridge Expansion Joints

Sir—The materials and research department of the State Division of Highways in California has been conducting a series of tests on the starting and sliding friction of bronze expansion plates used in bridge construction.

Six sets of plates, ranging from hard bronze similar to S.A.E. Specification No. 62, to a relatively soft lead bronze containing as high as 25 per cent of lead, are being used in the test. Very interesting results have already been secured which encourage us in the belief that by the time the test series is completed information of material value relative to the action of bronze expansion plates under service conditions will be obtained.

When the tests are completed the results will be published for the benefit of all who may be interested. Meantime, during the completion of the experimental work, it is desired to have the benefit of as much information as possible relative to any similar investigations which may have been conducted either in the United States or in Europe, and if any reader of *Engineering News-Record* has knowledge of such tests the undersigned will appreciate receiving specific reference thereto.

T. E. STANTON,
Materials and Research Engineer,
California State Division of Highways.

Sacramento, Calif.,
Feb. 10, 1930.

Restricting the Practice of Engineering

Sir—In his letter, under the above title, published in the Jan. 30 issue of *Engineering News-Record,* Morris Kampf, consulting engineer, has raised a question to which the engineering profession must make answer either with a "Yes" or a "No."

The condition which Mr. Kampf describes must be remedied without delay. Negative action on the part of the engineer at this time can only act as a silent indorsement to the great wrong done them.

The maternal instinct—the right to mother one's own child—should prompt every engineer to leave no stone unturned until the status of the engineer is returned to its proper place.

United effort, intelligently directed, is the weapon to use. The most effective way to get results is for all qualified engineers to join the New York State Society of Professional Engineers and thereby make that body powerful enough so that its influence, as a unit, may be directed toward the common cause.

JOHN C. SCHULZE,
Licensed Professional Engineer.

Croton-on-Hudson, N. Y.,
Feb. 6, 1930.

News of the Week

Report Favors Railway Tunnel Under English Channel

Recommendation that a twin-tube railway tunnel 39 miles long be constructed under the English Channel to connect England and France was contained in a report issued by the British Channel Tunnel Committee, which has been studying proposed methods of communication between the two countries. The tunnel is favored by four of the five members of the committee, the dissenter objecting on the ground that the resultant economic advantages of the scheme are uncertain.

Although geologic conditions at the site are held to be favorable, the report states that no definite conclusions upon the practicability of the scheme can be reached until a pilot tunnel, which would cost approximately $27,160,000, is constructed. Once this is completed and favorable conditions are assured, the twin railway tubes, each 18½ ft. in diameter, can be constructed for an additional estimated expenditure of $121,120,000, the pilot tunnel being used for ventilation and drainage purposes.

The committee believes that the tunnel can be built, maintained and operated by private enterprise at a cost which will permit tolls no greater than those now enforced on the cross-Channel voyage. No consideration is given to military objections, as these must be passed upon by the Committee of Defense.

ERECTING LONDON'S LARGEST OFFICE BUILDING WITH RECORD SPEED

Steel for the largest office building in London, now under construction for Anglo-Properties, Ltd., is being erected at an average rate of more than 400 tons per week. A new record for England was established during the week ended March 1, when 1,080 tons of steel was placed by Dorman, Long & Co., Ltd., contractor for the steelwork. On the Bank of Manhattan Building, recently completed in York City, an average of 1,000 tons of steel per week was placed over a period of fifteen weeks, with a maximum weekly tonnage of 2,130. The Anglo-Properties Building will contain a total of 12,000 tons of steel and will provide 725,000 sq.ft. of rentable office space. The architect is Sir Frank Baines, the general contractor John Mowlem & Co., Ltd., and the consulting engineer Harley H. Dalrymple-Hay, with whom are associated Sharman & Travers Morgan.

South Carolina Sells First Part of Highway Bond Issue

Highway bonds to the amount of $10,000,000, the first of a total issue of $65,000,000 for road construction, have been sold to the South Carolina National Bank at a premium of $235,976, reducing the nominal interest rate of 4½ per cent to an actual rate of 4.31 per cent. Four bids were submitted. As noted in previous issues, the validity of the bonds has been unsuccessfully contested in both state and federal courts, the case being finally settled by the refusal of the U. S. Supreme Court to accept the case on appeal.

I.C.C. Defied as Work Starts on Electric Railway Extension

Construction has been started on a proposed extension of the Piedmont & Northern Railway from Gastonia to Spartanburg, S. C., in defiance to a ruling of the Interstate Commerce Commission refusing permission for the extension and in face of probable injunction proceedings on the part of steam lines operating through this territory. As the Piedmont & Northern is an electric railway, the case is regarded as furnishing a precedent that will definitely settle the jurisdiction of I.C.C. over carriers of this nature.

Wanaque Water-Supply Project Completed March 20

Formal dedication of the Wanaque dam and aqueduct, which will supply 100,000,000 gal. of water daily to ten municipalities in northern New Jersey, took place at the dam March 20. The $27,000,000 project consists of a 300-ft. earth dam with concrete core wall, several smaller auxiliary dams, and a 20-mile aqueduct of single and double steel pipe with two tunnel sections. The contracting municipalities which will be served include Newark, Kearny, Paterson, Passaic, Clifton, Bloomfield, Glen Ridge and Montclair. By later arrangement the cities of Elizabeth and Bayonne will also utilize some of the water.

Completion of the aqueduct, the last portion of the project to be built, enabled the contractor, the T. A. Gillespie Co., to collect a bonus of $240,000 offered for completion in advance of the contract date, July 24, 1930. The final rivet was driven into the pipe Feb. 13. Test results showed a leakage of approximately 6,000 gal. per mile per day, as against the specified allowance of 8,500 gal. per mile per day.

Contract for the construction of the aqueduct was awarded to the Gillespie

company Dec. 20, 1928, for $5,127,628. It called for supplying and placing approximately 161,000 ft. of 74-in. lock-bar steel pipe. This award was noted in *Engineering News-Record*, Dec. 27, 1928, p. 969. As stated in our issue of Nov. 14, 1929, p. 786, a bonus of $2,000 a day was offered the contractors for completion earlier than the contract date, providing that no bonus would be paid unless this date was anticipated by at least 60 days. Fuller & McClintock, of New York City, were consulting engineers for the North Jersey District Water Supply Commission, under whose supervision the project was built.

Carelessness Causes Accident

In preparing for sewer work near Chicago a contractor moved large pipes across the Chicago & Northwestern Railway tracks on skids hauled by a tractor. On March 18 the hauling chain broke, leaving a loaded skid on the track. Before warning could be given this obstruction was struck by a fast train, which was derailed and fouled the adjacent track, where it was run into by a second train. One engineman was killed and several persons were injured, while there was great property damage. It does not appear whether the contractor had permission to handle his material in this way or whether the section foreman had taken any steps to warn the contractor or to protect traffic.

Central Credit Bureau Set Up in Illinois

For the purpose of eliminating overextension and other loose credit practices, the Illinois Highway and Municipal Contractors, a chapter of the Associated General Contractors of America, has established in that state a credit bureau under the control of a committee consisting of equal representation from three groups: contractors, distributors of crushed stone and distributors of sand and gravel. This credit bureau will supervise purchase of material for all "specification" work within the State of Illinois excepting Cook County, this work including state, county, municipal or township contracts, but not covering construction other than hard-surface pavements or concrete structures. Material will be sold to contractors upon a cash discount basis, it being provided that for all material shipped in any one month there shall be granted a substantial cash discount for payment on or before the 15th of the following month. The account shall become due on the first of the succeeding month and, if payment is not made at that time, the contractor is automatically placed upon a cash-with-order basis.

Routine procedure for effecting these regulations is as follows: On the first of each month duplicate invoices for all material shipped during the preceding month shall be rendered by the producer to both the consumer and the central bureau. If full payment is made to the bureau by the 15th of the month, as determined by the postmark, this payment shall be marked "approved for discount" and immediately forwarded to the producer, who will issue a check for the cash discount in the name of the consumer and mail it back through the bureau, where the transaction will be closed and the check forwarded to the consumer. When payment is not made on this basis, the full amount of the account falls due on the first of the next month, upon which date the bureau ascertains from both producer and consumer the status of the account and, if payment has not been made, the consumer is placed upon a cash-in-hand basis. All producers who are a party to the agreement are advised of this status upon request. In addition, the producer effected will take immediate legal steps to protect his account.

It is suggested that the cash discount for early payment shall be 10c. per ton, and the producers have agreed to contribute to the bureau 5c. a ton for all business concerned, which funds shall be used to defray the expenses of the operation. Any excess will be expended as approved by the joint committee from the three groups.

Regional Districts Proposed in New Jersey

Bill Before Legislature Would Divide State Into Four Sections to Control Public Works and Utilities

NEW JERSEY will be divided into four regional districts with governmental powers to provide and operate public works and utilities if a bill drawn by a legislative committee created in 1929 to study regional needs and means for supplying them, now before the legislature of that state, becomes a law. Each district would have power to do anything that can now be done by cities, towns, boroughs, or counties, provided the works or utilities were to serve two or more minor civil divisions or counties.

The names and general locations of the four proposed districts, and the counties within each, follow: North Jersey Metropolitan Regional District, the eight counties of Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset and Union; South Jersey Metropolitan, the six counties of Burlington, Camden, Cumberland, Gloucester, Mercer and Salem; Atlantic, the four counties of Atlantic, Cape May, Monmouth and Ocean; Delaware Valley, the three counties of Hunterdon, Sussex and Warren.

Government of each regional district would be vested in a district commission having one elective member from each county. The commissioners would serve terms of four years and would be "entitled" to a salary of $5,000 and expenses, but to the chairman $1,000 extra would be paid. Each commission would, at its discretion, appoint "an executive officer to supervise and co-ordinate the works of the district and to study and recommend to the commission such public works and undertakings," with "estimates of cost and recommendations for financing" as he might "deem wise." Each commission could engage necessary "clerical, engineering, legal, technical, advisory and ministerial assistants" and other employees.

The bill makes it the specific duty of each commission "to undertake a continuous study of the needs of the district, in whole or part, as they relate to public works, services and utilities," and after having held public hearings to "adopt a regional plan for the coordinated development of the district as a whole, and to study the possibilities and advantages of co-ordinating or consolidating existing and new public works, services and utilities, whether publicly or privately owned and (or) operated." The commissions would have authority, either by their own initiative or at the request of any municipality or county within their respective districts, "to construct, purchase or otherwise acquire and maintain and operate any public works or utilities affecting more than a single municipality or county, of a type or character which any municipality or county therein, within its own territory and for the use of its own inhabitants, would have the power to construct," etc.

The commissions would also have power of eminent domain, but this would not "extend to properties owned" by municipalities, counties or commissions. The bill provides for allocating costs incurred by the district by distribution over either the district as a whole or such parts of it as are peculiarly benefited. Outlays for public works exceeding $2,000 would have to be let by contract, after advertisement, to the "lowest responsible and qualified bidder." Broad powers of co-ordination of existing and projected works and utilities within the district would be had by the commissioners.

Financing Powers

The powers of financing district enterprises already indicated include the taxation of the district as a whole or by special taxation districts coextensive with services rendered; contracts with municipalities or counties under which these would bear the entire or any part of the cost of works authorized; special benefit assessments; and bond issues "pledging the full credit of the district." For general expenses district commissioners would have power to levy a tax on the entire district not to exceed one-twentieth of one mill upon each dollar of assessed

valuation. District bond issues could not exceed 2 per cent of the average of the last three preceding valuations of real property, including improvements within the district. Yearly budgets would be required and also annual reports, copies of both to be submitted to the various counties and municipalities within the district. The State Department of Municipal Accounts would have supervision of the accounts and reports of regional districts.

Because "of the peculiar conditions prevailing in the North Jersey and South Jersey Metropolitan Regional Districts on account of the large and rapidly growing population and the immediate need to provide major works in said districts of a type too great to be constructed by individual municipalities or counties or by joint contract between them," these two regions would begin to function immediately after the bill was enacted. In the two other and much less densely populated regional districts, the act would not become operative until after approval by a majority of the counties, on a referendum vote.

Coal Pocket Designer Indicted for Manslaughter

Investigation of the collapse of the steel framework of a coal pocket on the Harlem River in the Bronx, New York City, which caused the death of three workmen (*Engineering News-Record*, Feb. 27, 1930, p. 377), has resulted in three indictments by the Bronx County Grand Jury, two against Paul Orzel, the designer, and one against McNulty Bros. Coal Co., Inc., the owner of the pocket. The investigation was made by the district attorney of Bronx County, who presented the case to the Grand Jury. Accompanying the indictments, the Grand Jury filed a presentment, directing attention to inefficient administration of the engineer and architect license laws and to unsatisfactory organization of the dock department of New York City.

The most serious indictment, against Paul Orzel, designer of the coal pocket, for manslaughter in the second degree, charges him with culpable negligence, for which the maximum punishment is fifteen years' imprisonment and $1,000 fine. The second indictment against Mr. Orzel was for violation of sections 1450 and 1476 of the education law, referring to the licensing and registering of engineers and architects respectively. Mr. Orzel held neither an architect's nor an engineer's license, a misdemeanor carrying a maximum punishment of $500 fine and three months' imprisonment. The indictment against the coal company was for "building a structure on waterfront property without a proper permit," punishable as a misdemeanor, with a maximum fine of $500.

The investigation disclosed that Christ Nilson, of Brooklyn, was employed by the coal company as general contractor, that Nilson purchased the necessary steel from the Central Structural Steel Co., of the Bronx, and that the steel was furnished in accordance with plans and details drawn by Paul Orzel, who was engaged by the Central Structural Steel Co. No indictments against the latter company were brought in.

In its presentment, the Grand Jury stated that the laxity of public officials in ascertaining whether persons filing plans are licensed as engineers or architects presents a serious situation which merits prompt attention. "It is just as important," said the Grand Jury, "to the life, health and property of our citizens that the provision regarding the licensing and registration of such men shall be as strictly enforced as the provisions covering the licensing of doctors, lawyers and other professional men." The presentment also called attention to the danger inherent in divided responsibility among officials in the dock department charged with the duty of preventing the erection of such structures as this coal pocket. Among the things recommended is that any inspector of the department should be given the necessary authority to stop any work on wharf property that is being prosecuted without a permit. The investigation also disclosed that draftsmen in the dock department have been drawing plans for contractors, these plans later to be passed upon by the dock department in issuing permits. The Grand Jury entered a protest against this practice and expressed the belief that a rule should be promulgated forbidding it.

The Business Outlook

Unemployment is a serious problem in America for the first time in nine years. Thorough analysis and survey is all but impossible. Reliable statistics are not to be had. *The Business Week*, however, has investigated in typical industrial areas from coast to coast in an attempt to get a fair cross-section. Several important conclusions appear: (1) The unemployed are about as numerous as in 1921. (2) Relief measures are not too well organized, probably because the January "false spring" of business revival led the country to believe the problem would disappear quickly. (3) The jobless are remarkably cheerful. (4) Employers, in encouraging numbers, have abandoned the old, easy way of discharging men wholesale. (5) There has been some effort to supply public work.—*Conclusions of a survey by The Business Week, March 26.*

Plan Proposed for Long Piers at New York

A plan by which the pierhead line of Manhattan Island could be extended a maximum of 200 ft. into the Hudson River between 33d and 59th Sts. without decreasing the channel width, thus meeting objections of the U. S. War Department to proposed pier extensions, has been offered for consideration by William B. Moss, associate engineer of the New York Harbor Line Board. The plan involves adjustments between New York and New Jersey, providing, in detail, for the advancing of the New Jersey pierhead line, with corresponding recession on the New York side, along a portion of the river and a corresponding advance in the New York pierhead line, with recession by New Jersey, in the district already mentioned. Each state would gain in pier length in certain districts without reducing the width of the river channel.

Study 380-Ft. Dam for San Gabriel Site

Construction of a 300-ft. flood-control dam in the San Gabriel Canyon at the Forks site, which was condemned last fall as unsafe for a higher dam, is being considered, according to an announcement by E. C. Eaton, chief engineer of the Los Angeles Flood-Control District. County flood-control engineers are studying the possibilities of the following types of dams: rockfilled, rock and earth filled, a combination of rock and concrete, and earthfill. The proposed 380-ft. dam would create a lake holding 130,000 acre-ft. of water.

Testing Society Holds Regional Meeting in Detroit

Some 75 subcommittees and twenty committees of the American Society for Testing Materials met in Detroit March 17-21. Fittingly, most attention was paid to matters relating to the automobile industry such as metals, corrosion, oils and fuels. Of main interest to the civil engineer were meetings of the committees on cement, on road and paving materials and on drain tile. Progress reports only were made in most cases.

Committee C-1 on cement reported a 47 to 4 favorable vote on the proposed tentative specifications and tests for high-early-strength portland cement and a highly favorable vote of about the same count for the eleven items of revision proposed in the standard specifications and tests for portland cement. These votes are the results of a letter ballot of committee members. Both standards will come up for final adoption at the annual meeting, subject to the necessary nine-tenths vote of the society membership. The principal changes in the portland cement specification are the raising of the tensile requirements at seven days from 225 lb. to 275 lb. and at 28 days from 325

lb. to 350 lb. The specifications for high-early-strength portland cement are essentially identical with the present standards for portland cement with the exception of the requirement for sulphuric anhydride at 2½ per cent instead of 2 per cent and a tensile strength of 275 lb. in one day and 375 lb. in three days.

Proposed specifications on mortar cements submitted were referred back to the subcommittee for further consideration. More manufacturers are needed on the committee and certain additions to the personnel were made. The governing body will be asked to appoint a committee on methods for testing natural and mortar cements for masonry use, which will not, however, relieve the cement committee from preparing a specification for the material.

H. F. Gonnerman, manager of the research laboratory of the Portland Cement Association, presented further results of an elaborate series of tests made in many different laboratories comparing the plastic mortar compression cube test with the standard briquet test. In general the cube test appears to offer a better criterion of concrete strength than the briquet test. A progress report was made last June and these results with possible recommendation will be available at the coming annual meeting in June. In closing the meeting P. H. Bates, chairman, stated emphatically that it is time to reorganize the committee and look critically into its aims and procedures. For this purpose a committee was appointed.

Report was made on the work of the Cement Reference Laboratory in the Bureau of Standards, for which Congress has appropriated $12,500 and the Portland Cement Association $12,500. Three field men are maintained who visit and inspect various laboratories, investigate tolerances that need revision and check on method. According to investigation in only twelve of 88 cases noted were the moisture provisions properly carried out. Air temperatures were found varying from 45 to 100 deg. C. and water temperatures from 7 to 90 deg. C. It is proposed to get out a manual on how to make tests and how to use and care for testing apparatus. A regular course of instruction for laboratory workers is also a future possibility proposed.

Report Favors Strengthening of Hollywood Dam

In a report on the stability and safety of the Hollywood dam, submitted to the Los Angeles, Calif., Board of Water and Power Commissioners, H. A. Van Norman, Louis C. Hill and A. L. Sonderegger, commissioned to make a study of the structure, state their belief that "under no conditions is it safe to eliminate Hollywood reservoir." Construction of an earth and rock fill of ample dimensions against the downstream face of the dam is recommended, both because this would add to the stability of the structure and because of the psychological effect it would have, changing "the apparent menace to a pleasing view carrying no suggestion of a dam." The report states that provision of this fill "would make it impossible for the dam to fail if subjected to an earthquake shock great enough to destroy Hollywood." It is furthermore stated that, if the water is held at elevation 715, the resultant of all pressures will pass about through the middle of the base of the dam, rendering the latter still safer.

ENLARGING JOHNSTOWN'S WATER SUPPLY

Building the $1,750,000 earth dam of the Johnstown (Pa.) Water Co., which will be 110 ft. high and 500 ft. wide at the bottom. The reinforced-concrete core wall tapers from a bottom thickness of 4 ft. to 1 ft. at the top.

New Steel Clauses Added to New York Building Code

An important amendment to the building code of New York City, involving a large number of the recommendations made by the Merchants Association's committee on steel and iron, became immediately effective on March 25, when Mayor Walker signed an emergency bill drafted for the purpose. Among the new provisions, all of which closely follow the American Institute of Steel Construction specifications, are an 18,000-lb. unit stress; reductions in design live loads for residences, hotels and office buildings; new wind design specifications in which, for tall buildings, a 20-lb. per sq.ft. wind load is assumed to act on the building above a plane 100 ft. from the base and to be resisted entirely by the steel frame; heavier load requirements for floors and driveways subjected to heavy trucking; and permission to use fusion welding, under rigid inspection and specification. In addition to the structural steel clauses several changes are made in the prescribed stresses for concrete reinforcing bars, these changes being largely revisions upward.

Los Angeles Seeks More Water

The California Railroad Commission has issued an order to the Southern Sierras Power Co., Riverside, Calif., to appear at a hearing in Los Angeles June 10, 1930, to show cause why the commission should not proceed to fix the just compensation to be paid by the city of Los Angeles for the lands, property and water rights of the company on Leevining Creek and Rush Creek, in Mono County. This action was taken upon application of the city, which proposes to take over these properties and rights under condemnation proceedings, as an addition to the municipal water and power project. The properties consist of 240 acres on Leevining Creek at plant 3 and two parcels on Rush Creek, one consisting of 160 acres and the other of 428.91 acres, making a total of 828.91 acres. The city is seeking to acquire these lands for the riparian rights that go with them as a part of the city's program to secure an additional water supply for its domestic purposes.

Large Pumping Stations Opened to Drain Dutch Land

As a part of the project for reclaiming portions of the Zuyder Zee, the Dutch government has opened the first two of the required pumping stations for the project. These will serve the first section to be reclaimed, known as the Wieringen Polder, which lies south of the island of Wieringen and contains 49,420 acres. The water now covering this section will be removed in about eight months by the two new stations, one of which will operate by diesel motors, the other by electricity at 3,000 volts. The combined capacity of the two stations is approximately 159,000,000 cu.ft per day.

Bond Issue Proposed to Protect Water Supply of New Jersey

Provision for a bond issue not exceeding $7,000,000 for the acquisition of lands and water rights for the protection of potable waters of the State of New Jersey is contained in a bill recently introduced before the legislature of that state. Should this act be passed, it must be approved by a majority of the voters of the state before it can take effect. The fund thus created will be under control of the State Water Policy Commission, which may request the sale of the entire amount authorized or any part thereof as its need for funds arises. By the provisions of the act the bonds must be sold at par, shall bear an interest rate not exceeding 5 per cent, shall mature in twenty years from date of issuance and shall be redeemed by a sinking fund to which annual payments shall be made from the proceeds of a state-wide tax, unless receipts from other sources shall be sufficient to meet the yearly requirements.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Agreement Reached on Federal Aid Increase — Study Uses of Potomac—Colorado River Power

AN AGREEMENT was reached by the conferees on the federal-aid road bill on March 25, and the House of Representatives approved the conference report on the same day. It cannot be acted upon in the Senate until Monday, as the upper chamber adjourned for the remainder of the week after passing the tariff bill. It is expected that the conference report will be approved promptly by the Senate, and arrangements already have been made for the President to sign the bill Wednesday. The bill carries an additional $50,000,000 for the fiscal year beginning July 1, and authorizes federal aid to the extent of $125,000,000 for the fiscal years of 1932 and 1933. The extra $50,000,000 may be placed under contract immediately after the signing of the bill by the President.

The provision of the bill increasing from $15,000 to $25,000 per mile the maximum amount of federal aid that may be expended was modified so that federal participation is to be limited to $15,000 per mile when the 7 per cent system shall not have been surfaced and that special certification by the director of the Bureau of Public Roads and of the Secretary of Agriculture must be secured before any payment in excess of $15,000 per mile is made. In addition to allowing the $15,000 minimum to be exceeded in states that have completed their 7 per cent system, an amount up to $25,000 may be certified where economy in construction will result. This latter proviso is to take care of difficult construction.

The compromise seems to have met the situation to the satisfaction of all, but regret is being expressed that the solution was not forthcoming earlier. As a result of the disagreement in conference, the measure has been delayed since Jan. 29. Had the conferees acted more promptly two months of employment, it is contended, would not have been lost in the period of the year when unemployment was greatest.

Boulder Dam Progress

A Boulder dam power agreement has been reached, according to an Interior Department release dated March 23. Nobody has agreed but the California factions. Not only Arizona but probably Nevada and Utah will oppose the plan, which is closely similar to the tentative allocation previously backed by Secretary Wilbur. Apparently the administration is using California's internal understanding on power, following the earlier one on division of water, to force a showdown with the other states and to break the Boulder dam deadlock. Construction cannot begin under the law until the power contracts have been let. With the recent agreement, the main parties in shape to sign appear to have so committed themselves that final pen scratches on the contract forms are a formality to be expected any day now. It is understood that Los Angeles and the power companies will contract for all power not otherwise taken, thus underwriting the project as required under the Boulder Canyon act. This done, appropriations can be rushed through Congress, with budget bureau approval and possible executive impetus.

But when will work commence? Boulder dam is still on paper. The minute a shovel is stuck in the ground, Arizona can obtain an injunction which will halt work until conflicting rights have been determined. Rather than postpone this day, the administration seems to be hastening it, so that the legal battle, if any, can begin and push through to an early end.

Power Allotments

The new allocation divides Boulder dam power on a percentage basis as follows: Arizona, 18 per cent; Nevada, 18; Metropolitan Water District, 36; Los Angeles, 13; eleven applicant municipalities in California, 6; Southern California Edison and associate power companies, 9; total, 100 per cent of the primary power. In addition, the water district gets all it can use of the secondary power and unclaimed allotments for pumping water from the Colorado River for supply purposes. Whatever is left, and doubtless there will be something left while the project is getting established, is divided half and half between Los Angeles and the four power companies—the Southern California Edison Co., Southern Sierras Power Co., Los Angeles Gas & Electric Corp. and San Diego Consolidated Gas & Electric Co.

Broad control powers are retained by the Secretary of the Interior in shaping future transactions under the contract. The primary power is to be charged at 1.63 mills; secondary to be determined later. The federal government will build and operate the power plant, cost to be allocated among contracting parties. Contracting parties other than states must pay in trust for Arizona and Nevada compensation in lieu of taxes on machinery and equipment. A clause will be inserted in all contracts insuring distribution of power developed at Boulder dam at a price considered by the Federal Power Commission as fair to all consumers.

Other Colorado River Projects Opened

While the Boulder dam act lifted the ban of Congress against granting water-power applications on the Colorado River and its tributaries, the Federal Power Commission has continued all of these projects under suspension until the entire situation could be appraised. The commission has now decided to proceed actively with the determination of the status of these projects. Licenses will be issued to construct run-of-stream plants where no controversy is involved and 90 days will be given for all applications on the main river and on the tributaries between Green River and the Gila to show why the projects should be continued in good standing. It will be necessary for such applicants also to establish that their project will not interfere with the Boulder Canyon development and the best scheme of future additional development.

Park vs. Power at Great Falls

Action in the Senate district committee on the bill setting aside the gorge of the Potomac River above Washington as a park has been deferred until more of the engineering facts concerning the advisability of power development in the area can be established. As it passed the House, the bill provided for the location of parks in the region, but left the matter of power development for future determination by Congress. Those who advocate the utilization of the power resources of the river contend that it will be impossible to secure permission for the construction of dams after the valley has been set aside for park development.

During a recent hearing on the bill, the committee was informed by Major Brehon Somervell, army engineer in charge of the Washington area, that combined park and power development in the upper Potomac is possible. In accordance with instructions from Congress issued in the water resources bill, Major Somervell has made a survey of the Potomac relative to the matters of power development, flood control and navigation improvement. As the result of this survey it has been shown that impounding water in hydro-electric reservoirs will enhance the beauty of the region for park development.

As to the power possibilities, Major Somervell stated that with a 50 per cent load factor, 211,000 kw. can be obtained. There is a gap in the power system along the Atlantic coast which a large hydro-electric plant on the Potomac

would help to fill, he pointed out. The Potomac is far more valuable for power development than is the Susquehanna, Major Somervell claims. This is because the Potomac is more susceptible to regulation, as it flows through a more unsettled territory in its upper reaches than any of the large streams on the Atlantic coast and therefore will permit the construction of as many regulating dams as necessary.

As to other benefits that would be brought about by the construction of hydro-electric dams, Major Somervell testified that the work of improving the river for navigation would be expedited and that benefits would be extended to the water-supply department of the city of Washington. He expressed the opinion that power development would save $100,000,000 and would provide a park that would be even more beautiful than the one originally contemplated. This money would be realized in lower electric rates, in savings to the water-supply system and in savings in the construction of bridges, and would make it unnecessary to buy the land on the sides of the river.

Personal Notes

FRED J. KLAUS, for the past ten years chief engineer of the East Bay Water Co., Oakland, Calif., has been appointed city engineer of Sacramento, Calif., succeeding B. Clark, who recently resigned. The appointment will become effective April 1.

JOHN S. SEWELL, of Birmingham, Ala., has accepted the nomination as president of Allied Construction Industries, Inc., a local organization formed to improve practices in the construction industry in Birmingham. OLIN H. HORTON will be secretary-treasurer.

S. C. SMITHWICK, who has been associated with the city engineer's office in Seattle, Wash., for the past ten years, has joined the staff of the Portland Cement Association and will have charge of the Spokane district, comprising the "Inland Empire" and northern Idaho.

GEORGE B. HILLS, consulting engineer, of Jacksonville, has been appointed a member of the Florida State Road Department to fill the vacancy caused by the resignation of G. D. Perkins. Mr. Hills, a graduate of Armour Institute of Technology, has been in engineering practice in Florida since 1913.

GEORGE G. RADCLIFF, of Sacramento, Calif., has been named vice-president of the American River Hydro-Electric Co. and general manager of its Sacramento interests. The company's particular aim is to negotiate a contract with the state for the construction of a dam for flood control and the generation of hydro-electric power on the American River at Folsom in accordance with an act of the 1920 legislature.

S. B. WASS has been appointed terminal engineer in connection with the Montreal Terminal development system with jurisdiction over that portion of the development outside of the central station area. Mr. Wass was graduated from the University of Toronto in 1903, and has been for many years connected with the engineering staff of Canadian National Railway system.

Obituary

ALBERT L. WEBSTER, of New York City, a sanitary engineer who had served as consultant in the construction of the Grand Central Terminal, the Public Library and other buildings in New York, died on March 24.

CASSIUS MCCARL LEMLEY, state geologist of West Virginia and geological engineer for the Baltimore & Ohio Railroad, died on March 8 in Morgantown, W. Va. Mr. Lemley was a member of the first class in engineering to be graduated from the University of West Virginia in 1891. He entered the employ of the B. & O. in 1900 and in 1916 was made a consulting engineer for the road.

LOUIS F. BARZELOTTI, for the past seventeen years city engineer of Lodi, Calif., died in that city March 15 of heart failure. He was 70 years old.

CLIFTON SHARPE THOMPSON, who was for 40 years bridge and construction superintendent for the Denver & Rio Grande Railroad, died in Denver, Col., March 11, at the age of 77.

T. RHYS SMITH, of New York, died suddenly of heart disease on March 24. Mr. Smith, who was 73 years old, was chief engineer on the construction of a large part of the work of construction of the Canadian Pacific Railway.

GEORGE W. FRY, president of the West Texas Utilities Co., died on March 14 at his home in Abilene, Tex., aged 48. For a time Mr. Fry was a civil engineer for the Chicago, St. Louis & Minneapolis Railroad.

PETER JUNKERSFELD, vice-president of the Stone & Webster Engineering Corporation, died at his home in Scarsdale, N. Y., on March 18, aged 61. Mr. Junkersfeld, soon after his graduation from the University of Illinois in 1895, entered the employ of the Chicago Edison Co., with which he remained for 24 years, and in 1916 he was elected president of the Association of Edison Illuminating Companies. In 1919 he became associated with Stone & Webster in New York. He resigned from this position in 1922 to become a member of McClellan & Junkersfeld, Inc., engineer and constructor. In 1928 his firm was merged with the division of construction and engineering of Stone & Webster and Mr. Junkersfeld became a vice-president of the organization. He was past-president of the American Institute of Electrical Engineers and past vice-president of the Western Society of Engineers.

CHARLES L. NEWCOMB, for 50 years identified with engineering and hydraulic work in the East, died at his home in Holyoke, Mass., on March 13, aged 76 years. Soon after his graduation from Worcester Polytechnic Institute in 1880, Mr. Newcomb went to New Britain, Conn., where he established what is said to be the first municipal lighting plant in the country. In 1881 he went to Holyoke and shortly afterward became superintendent of the Deane Steam Pump Co., later absorbed by the International Steam Pump Co., and still later controlled by the Worthington Pump & Machinery Corp. Mr. Newcomb served the city as councilman and as alderman and was chairman of the fire commission for seventeen years. During his service on the commission he invented a nozzle that converted the aerial ladder into a water tower. He was a past vice-president of the American Society of Mechanical Engineers.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 23-25.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual meeting, Augusta, Ga., March 31-April 2.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

INTERNATIONAL RAILWAY CONGRESS, Madrid, Spain, May 5-15. American vice-president, T. S. Morgan, 119 West 42d St., New York.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS will hold its fifth annual meeting April 14-16 at St. Louis. F. E. Dishner, Detroit, is secretary.

BALTIMORE SECTION, American Society of Civil Engineers, held its spring meeting March 20 at the Gibson Island Club. George T. Seabury, national secretary, discussed the relationship between the national body and the local sections. About 150 persons attended.

FLORIDA ENGINEERING SOCIETY will hold its annual meeting April 17-19 at Ocala. P. L. Reed, Gainesville, is secretary.

FLORIDA SECTION, American Water Works Association, the Florida State Board of Health and the University of Florida are sponsoring a four-day short course in water purification and sewage treatment to be held April 8-11 at Gainesville.

ILLINOIS SECTION, American Water Works Association, will hold its annual meeting at the Stevens Hotel, Chicago, April 23-24. J. J. Doland, Urbana, is secretary.

PACIFIC NORTHWEST SECTION, American Water Works Association, will meet April 24-26 at Portland, Ore.

TACOMA CHAPTER, American Society of Civil Engineers, at its recent monthly session decided to make a strong bid for the 1931 Western regional meeting of the society. Tacoma is listed among four places under consideration. Seattle had the Western regional meeting in 1926. W. C. Raleigh was named chairman of a committee to present the city's claim at the quarterly session to be held in Sacramento, Calif., April 22-24.

Construction Equipment and Materials

Lumber Manufacturers Establish Research Laboratory

Additional facilities for establishing facts of value in the manufacturing and marketing of lumber have been set up by the National Lumber Manufacturers Association through the establishment of its own research laboratory in one of the science buildings of the Catholic University of America, Washington, D. C. The new laboratory will supplement the co-operative assistance now furnished by the Forest Products Laboratory of the U. S. Forest Service and other special co-operative investigations. It will be used principally to initiate investigations that may later develop into general problems which can be turned over to the Forest Products Laboratory or other public institutions for fuller study.

Research work of the National Lumber Manufacturers Association, previously carried on through outside agencies, is under the direction of the board of directors and under the immediate guidance of the research advisory committee, of which C. Arthur Bruce, Memphis, Tenn., is chairman. Administration is in the hands of Frank P. Cartwright, chief engineer of the association. The new laboratory, which began operation March 10, is in charge of J. E. Myer, a graduate of the New York State College of Forestry at Syracuse University. The first tests that will be put under way will concern fire-retardant treatments and abrasion resistance of woods.

Asphalt Institute Adds to Staff and Elects Officers

The newly organized Asphalt Institute, which succeeded the Asphalt Association on Jan. 1, has elected the following officers for the fiscal year 1930: Leroy M. Law, St. Louis, Mo., president; W. H. Kershaw, New York, N. Y., vice-president; C. W. Bayliss, Philadelphia, Pa., vice-president; B. L. Boye, New York City, secretary, and Fisher Jones, New York City, treasurer. J. S. Helm, of New York, is chairman of the executive committee and J. E. Pennybacker, also of New York, is managing director.

On or about April 15 the institute will move to 250 East 43d St., New York, where it has leased the entire eighteenth floor. Larger general offices and a new and larger laboratory will be installed in these quarters, with F. C. Field, assistant chemical engineer, in charge. The entire research division will be under the supervision and direction of the institute's chemical engineer, Prevost Hubbard, formerly chief of research for the U. S. Bureau of Roads.

Activities of the institute will be extended to cover education and research in the use of asphalt for roofing, insulating and waterproofing as well as paving. B. E. Gray, formerly of the West Virginia State Highway Department and the U. S. Bureau of Public Roads, becomes director of the highway engineering division, succeeding W. E. Rosengarten, who resigned recently to accept a position with Day & Zimmermann in Philadelphia. Mr. Gray, who is widely known among the highway engineers of the country, entered upon his new duties March 20. Henry Krieger becomes assistant to Mr. Field.

The probabilities are that the ninth annual Asphalt Paving Conference, under the auspices of the Asphalt Institute, will be held in October, 1930, at Washington, D. C., just preceding the International Road Congress and simultaneously with conventions of other organizations identified with the road-building industry.

BRITISH COAL REACHES SEA BY 7½-MILE ROPEWAY

Keystone Photo

Extending from Tilmanstone Colliery to Dover Harbor, England, a 7½-mile ropeway, constructed at a cost of approximately $600,000, delivers coal direct from the mine to ships at the rate of 120 tons per hour. Each of the 520 buckets carries 1,624 lb. of coal and occupies about 90 minutes on a single trip. The ropeway is supported by 177 standards and passes through twin tunnels ¼ mile long through the cliffs of Dover. Storage bunkers at the harbor accumulate coal, which is loaded on shipboard at the rate of 500 tons an hour by automatic weighing machinery.

Southwest Road Show Holds Successful Meeting

All records for attendance were broken at the fifth annual Southwest Road Show and School held in Wichita, Kan., during the last four days of February. The school program, sponsored by the Kansas State Highway Commission, Kansas State Agricultural College and other interested organizations, was of great interest to contractors, county commissioners, highway officials and others connected with road construction. It was supplemented by approximately a hundred exhibits by manufacturers of road-construction equipment as well as by the U. S. Bureau of Public Roads, Kansas State Agricultural College, University of New Mexico, the Republic of Mexico and the states of South Dakota, Nebraska, Missouri, Kansas, Colorado, New Mexico and Oklahoma. The exhibits occupied twice as much space as was taken a year ago.

New Developments

Process Reproduces Black-Line Positive Prints

Black-line positive prints with white backgrounds can be produced direct from tracings without the aid of a negative or the usual washing and drying operations by means of a process developed by the Charles Bruning Co., Inc., New York City. It is claimed that this process will reproduce lines as thin and fine as ordinary map contour lines and that the resulting print will not rub off or run if the print is watersoaked. To make a print a special sensitized paper or cloth is run through a blueprinting machine with the tracing in the usual manner. Instead of using a developer, however, the exposed paper is run either through a developing attachment installed on the blueprinting machine or through a separate developing machine. In either case the exposed print is run through rolls, one of which dips into a shallow trough of developing solution. As this film of solution on the roller is not sufficient to wet the paper appreciably, it leaves the rolls quite dry. The

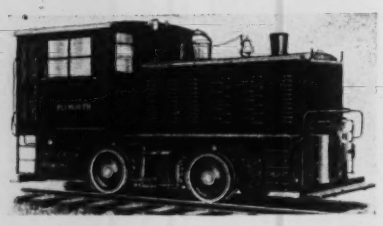
DEVELOPING MACHINE FOR POSITIVE PRINTS

separate developing machine is supplied in two forms, either for continuous roll development with electric motor attachment or in a portable hand outfit which can be transported anywhere and which is intended for use when only an occasional print is required.

The sensitized paper used in the process has the same printing range as rapid blueprint paper, and is furnished in two weights and several sizes of rolls. One weight of cloth is also available.

Six- and Eight-Cylinder Motors Used in Gasoline Locomotives

A new series of internal combustion locomotives announced by the Fate-Root-Heath Co., Plymouth, Ohio, are powered by Le Roi gasoline motors with either six or eight cylinders, according to size. Six cylinders are utilized in the 20-, 25- and 30-ton models, and an eight-cylinder V-type engine in 30- and 35-ton locomotives. A patented bar-steel frame of special construction utilizes semi-elliptic springs with the elimination of many parts ordinarily

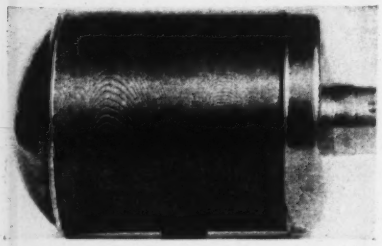


NEW GASOLINE LOCOMOTIVE

bolted to the frame. Easy riding on rough track is secured by the use of both side and cross equalizers, giving a true three-point suspension. Other features of the new models include unusually long and flexible springs, clutches which can be removed without disturbing either engine or transmission, electric starters and direct-driven air compressors.

Metal Screen Developed for Heavy-Duty Oil Filter

Much experimental work preceded the final perfection of the metal element for use in Purolator oil filters, recently announced by Motor Improvements, Inc., Newark, N. J. Requirements of a filter element include the provision of a large area in a small cubic space, low cost, accurate and uniform spacing of openings, a good rate of flow, and sturdiness to withstand cleaning without breakage. To meet these requirements the company has developed an element of wedge-shaped metal ribbon, on one side of which are accurately gaged raised spots forming spacers at regular intervals. These are 0.003 in. thick and separate the successive layers of the ribbon to form a filtering slot of that exact thickness. Because of the wedge shape of the ribbon the filtering slots are wider behind



OIL FILTER OF METAL RIBBON

than at the filtering edge, so that there is little likelihood of clogging. Much of the dirt filtered from the oil slides down to the bottom of the Purolator base, from which it can be drained by means of a plug. Dirt remaining on the surface can be washed off easily.

The metal element is not to be used in all models of Purolators, as certain classes of service require the use of the fabric filter element. Proper choice can only be made after a thorough study of the conditions to be met.

Business Notes

JEFFREY MANUFACTURING CO., LTD., Montreal, Canada, at its recent annual meeting elected John L. Connors director and vice-president and R. H. Ross secretary-treasurer to fill the vacancy caused by the recent resignation of F. N. Diehl. The new plant of the company at Montreal has been completed and is now in production. A complete stock of conveyor equipment is on hand, as well as a stock of the products of the Galion Iron Works & Manufacturing Co., a subsidiary of the Jeffrey Manufacturing Co.

VIRGINIA ROAD MACHINERY CO., INC., Richmond, Va., has been formed to distribute a general line of contractors' equipment throughout the state. J. M. Oates, formerly of Charlotte, N. C., is general manager of the company.

ARCO CO., Cleveland, Ohio, will build at Los Angeles, Calif., three brick buildings totaling 16,500 sq.ft. of floor space to house a paint-manufacturing plant, a lacquer plant and a varnish plant. The new factory will be known as the Arco Company, Ltd., of California, and will be under the general direction of Howard Wise. Howard Raeney will be general sales manager, and E. B. Hagar, who has been manager of the San Francisco branch, will be made district manager with headquarters in Los Angeles.

SIMPLEX WIRE & CABLE CO., Boston, Mass., has opened a branch office in Philadelphia, Pa., under the management of Elden L. Howe.

TUBE-TURNS, INC., Louisville, Ky., has appointed new distributors as follows: E. F. Keating Co., New York City; Himelblau-Agazim & Co., Chicago, Ill., and Stewart Machinery Co., St. Louis, Mo. W. P. Curley and A. L. Breyvogel will continue as managers of the New York and Chicago branch offices, respectively.

HELTZEL STEEL FORM & IRON CO., Warren, Ohio, announces the appointment of B. M. Clark as manager of sales to succeed W. J. Savage, resigned. Mr. Clark has been assistant manager of sales for several years.

CONNERSVILLE BLOWER CO., INC., Connersville, Ind., has awarded a contract for the immediate construction of a 25x125-ft. addition to its factory.

UNIVERSAL ATLAS CEMENT CO., Chicago, Ill., has announced plans for the construction of a $500,000 cement-distribution plant at Milwaukee, Wis. Plans call for the construction of from six to ten storage tanks and a large steel building. Each tank will have a storage capacity of approximately 75,000 bbl. of cement.

HARNISCHFEGER SALES CORP., Milwaukee, Wis., announces that R. H. McGredy has been employed in an executive sales capacity with headquarters at New York City.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio, has appointed C. Brigham Allen, Jr., district sales representative of the Philadelphia office.

INDEPENDENT PNEUMATIC TOOL CO., Chicago, Ill., has elected Frank B. Hamerly, Aurora, Ill., vice-president in charge of manufacturing.

COPPERWELD STEEL CO., Glassport, Pa., announces the addition to its engineering staff of C. H. Jensen, formerly with the Pittsburgh branch of the Byllesby Engineering & Management Corp., where he was engaged on overhead and underground transmission distribution design.

Costs and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1, 1930	**206.80**	**February, 1930**	**204**
Feb. 1, 1930	206.46	January, 1930	199
Mar. 1, 1929	207.78	February, 1929	378
Average, 1929	207.02	Average, 1929	317
Average, 1928	206.78	Average, 1928	287
1913.....	100.00	1913.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 27, with some comparisons, total as follows:

(In Thousands of Dollars)

	Mar. 27, 1930	Average Preceding Four Weeks 1930	1929
Buildings:			
Industrial.....	$23,467	$8,941	$7,462
Other	52,486	29,578	57,450
Streets and roads..	11,563	9,197	4,288
Other eng. constr..	8,637	40,264	27,650
Total.....	$96,153	$87,981	$96,850

Total, all classes, Jan. 1 to March 27:

1930	$826,072
1929	1,121,942

New Publications

Centrifugal Pumps—Charts giving data for the proper selection of single and multi-stage centrifugal pumps for all services are a feature of bulletin 200, published by GOULDS PUMPS, INC., Seneca Falls, N. Y. This 40-p. illustrated bulletin is the first of a series to be issued covering the entire line of pumps manufactured by this company.

Oil Filters—Principles of design and operation of H-W oil filters, as applied to Continental, Hercules, Waukesha, Wisconsin and Buda motors, are described in a series of pamphlets issued by the MICHIANA PRODUCTS CORP., Michigan City, Ind.

Flexible Couplings—Complete data on the ratings, dimensions and prices of Morse flexible couplings and speed reducers, as well as directions for installation, are given in an illustrated 24-p. bulletin of the MORSE CHAIN CO., Ithaca, N. Y. An explanation of the principles affecting flexible coupling design is included.

Excavating Equipment — New catalogs have been issued by BAY CITY SHOVELS, INC., Bay City, Mich., describing the Bay City three-quarter revolving, ¾-cu.yd. shovel, and the model K full revolving, ½-cu.yd. shovel. Both these units are convertible to crane, trench hoe, dragline or backfiller.

Diesel Engines—Data in regard to diesel engine design and operation are briefly outlined in a series of bulletins issued by the ATLAS IMPERIAL DIESEL ENGINE CO., Oakland, Calif., describing four- and six-cylinder diesel engines of its manufacture.

Surfacing Material — "Properties of Haynes Stellite" has been issued by HAYNES STELLITE CO., Kokomo, Ind., in a new and completely revised edition which gives a general description of the material, its physical and chemical properties and an explanation of its uses.

Unit Prices From Current Construction Bids

4,770-Ft. Rectangular Concrete Sewer for Columbus Project

THE fourth and largest contract to date on the Olentangy-Sciota intercepting sewer project for Columbus (Fig. 1) was awarded in the latter part of February, 1930, to the lowest of eleven bidders. This is Contract 1, Sec. 1, for 4,770 ft. 10½ ft. wide by 5½ ft. high, inside dimensions, of reinforced concrete lined throughout with vitrified-clay liner plates, and includes a river crossing 525 ft. long which is to be built as a low dam. Certain appurtenant work is included, as a concrete revetment, an abutment, steel sheet-piling cutoff walls, timber pile foundations and manholes.

The principal items bid are excavation and concrete. Excavation is of two classes: A, above El. 9, and B, below El. 9, between vertical lines 12 in. outside the limiting lines of the sewers. Bid prices include removal of whatever

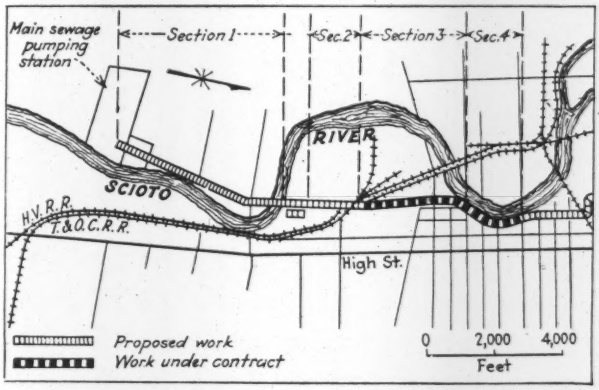


FIG. 1—LOCATION PLAN, OLENTANGY-SCIOTO INTERCEPTING SEWER, COLUMBUS, OHIO

materials encountered, to permit construction of sewer, river crossing and other structures, and the restoration of streets and sod. They also include backfilling and tamping or flushing with water. Any settlement of backfill within two years must be refilled by the contractor.

Concrete—The fine and coarse aggregates are measured separately and the sum of the two separate volumes (not

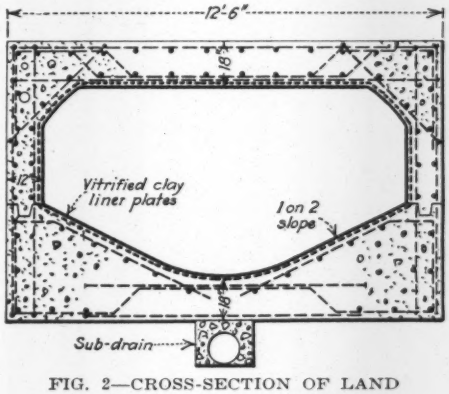


FIG. 2—CROSS-SECTION OF LAND PORTION OF SEWER

the volume of the resulting mixture) equals that shown in the "total aggregate" column of the following table:

Class	Cement Bags	Total Aggregate (Cu.Ft.)	Water (U. S. Gal.)	Strength at 28 Days Not Less Than (Lb. per Sq.In.)
A (Sewer)	1	6	6	2,500
B (Structures)	1	6	6	2,500

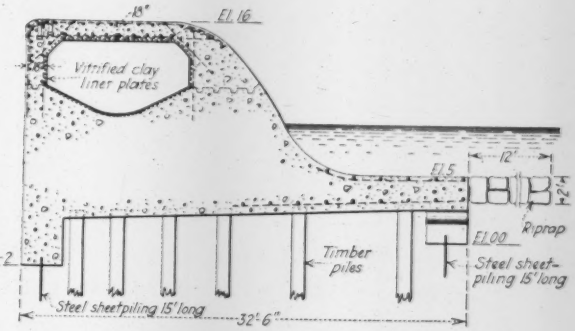


FIG. 3—CROSS-SECTION OF RIVER CROSSING

Steel reinforcement is paid for in place, and includes furnishing and bending. The mesh under item 6 is 4x4-in. No. 4 and is for reinforcing the revetment.

Lining—The sewer is completely lined with vitrified plates. In the inverts these are laid in a 1-in. mortar bed and settled firmly by sliding at least 6 in., so that the thickness of the mortar between plate and base is ¼ to ½ in. Liner plates on the sides and top are attached to the forms at all four corners before concrete is poured.

Other Items—The timber piles are not less than 9 in. at the small end and 12 in. 4 ft. from butt. The estimated quantity is based on 15-ft. lengths.

Steel sheetpiling to form permanent cutoff walls has ½-in. web. The quantity is the number of square feet of wall constructed and does not include piling for trench support.

The three lowest bids follow: (A) Ben Canini, Columbus, (awarded contract); (B) E. H. Latham, Columbus; (C) Swingle & Robinson, Columbus. Engineer's estimate, $359,363.50.

Item	Quantity	A Price	B Price	C Price
Exc., Cl. A (above El. 9), cu.yd.	33,400	$1.20	$1.35	$0.70
Exc., Cl. B (below El. 9), cu.yd.	12,600	1.20	1.35	2.25
Concrete, Class A, cu.yd.	8,010	10.85	10.85	12.00
Concrete, Class B, cu.yd.	4,650	10.85	11.20	12.00
Steel reinf. bars, lb.	1,484,000	.035	.0333	.04
Reinforcing mesh, lb.	14,200	.10	.077	.10
Vitr. clay liner plates, lin.ft.	4,770	5.00	5.86	5.25
Timber piles, lin.ft.	8,070	.60	.71	.70
Steel sheet piling, sq.ft.	17,600	1.25	1.06	1.35
Riprap paving, cu.yd.	310	3.00	10.44	4.50
Timber bulkheads	2	100.00	60.00	100.00
Manholes	7	100.00	203.00	100.00
Special manholes	1	400.00	271.00	350.00
Misc. cast iron and steel, lb.	20,000	.12	.06	.10
1½-in. telephone conduit, lin.ft.	4,790	.40	.2735	.25
3-in. electric conduit, lin.ft.	830	1.00	.63	.65
Total		$303,989.00	$312,018.37	$325,263.50

Highway Work in Maryland

BIDS were opened March 4, 1930, on a number of Maryland state highway jobs. The principal items were road oils and concrete paving, and prices of these are tabulated herewith. Column A of the oiling prices are award figures; Column B, second low. The concrete prices are the lowest two bids on each of the four jobs listed.

Oiling Six Sections, 414 Miles

Gal.	A	B	Gal.	A	B
84,502	$0.082	$0.0894	129,656	$0.0849	$0.085
58,622	0.0829	0.085	232,911	0.0915	0.0968
87,403	0.0834	0.0847	686,727	0.1420	0.152

Plain Concrete Shoulders, 18.9 Miles of 8-In.

Cu.Yd.	A	B	Cu.Yd.	A	B
10,250	2.28	2.29	7,900	2.12	2.29
10,600	2.04	2.12	22,150	2.67	2.72

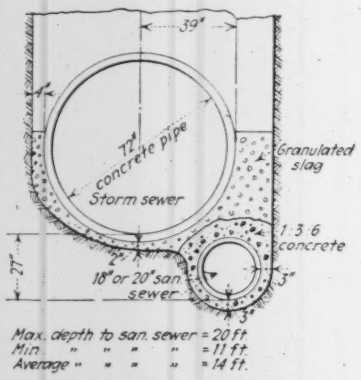
Unit Prices From Current Construction Bids

Two Storm-Sanitary Sewer Contracts in Euclid, Ohio; $197,603

ON JAN. 7 and 27, respectively, the village of Euclid, Ohio, received bids on two storm and sanitary sewer projects, one on St. Clair Ave., the other on Upson Road. Alternate bids were asked, but both contracts were awarded for concrete pipe. While the contractor submitted bids only on the sewer proper, the engineer included (a regular practice here) unit prices on six additional items, to provide means of paying the contractor for work not anticipated in the plans or to cover work on which close estimating is difficult. These items are listed below instead of being included in the tabulation of contract prices on these two jobs:

Concrete masonry for (1) repairing culverts broken into to direct the flow into the sewer, (2) incasing water mains lowered to permit sewer installation, (3) additional incasing around the sewer in poor soil; cu.yd. 1:2:4, $15.

Brick masonry for (1) additional foundations for manholes in poor soil, (2) reconditioning manholes broken into for sewer outlet, (3) closing larger stubs in manhole for future sewer connections; $20 per cubic yard.



TYPICAL CROSS-SECTION OF UPSON ROAD STORM AND SANITARY SEWER PROJECT, EUCLID, OHIO

St. Clair Ave. project similar except for pipe sizes.

Slag or cinders for driveways over trench, after backfilling and puddling, but needed only in periods of excessive rainfalls; $3 per ton in place.

Sand for backfill where excavated material is unsuited, or for backfilling under pavement or where pavement will be placed at once, as at intersections of main thoroughfares; $3 per cubic yard in place.

Labor for (1) connecting existing field or house drains encountered during construction, (2) rectifying possible defective drainage along street, (3) breaking into culverts, manholes, or existing sewers, (4) lowering water mains.

Experience has shown that frequently a bidder will gamble on the foregoing work not being done, as sometimes happens, and consequently bids high on the other items and very low on these. As an example, bids of 25c. per cubic yard have been received for brick masonry in place. To avoid this, the engineer prints on the proposal form the minimum prices that will be paid for work not specifically included in the contract.

Contract prices on the two projects follow: Upson Road, Manson Co., total $96,425. St. Clair Ave., A. C. Hattendorf Construction Co., total $101,177.50.

Items—St. Clair Ave.

	Lin.Ft.	
8 in. san. sewer in concrete, bit. jts.	100	$0.50
15 in. san. sewer in concrete, bit. jts., D. S.	8,800	2.10
15 in. san. sewer in concrete, bit. jts. in tunnel	40	6.00
12 in. storm sewer in concrete	200	1.50
15 in. storm sewer in concrete, D. S. cam. jts.	630	2.25
18 in. storm sewer in concrete, D. S. cam. jts.	660	2.50
24 in. storm sewer in concrete, D. S. cam. jts.	1,500	3.75
30 in. conc. storm sewer, gran. slag backfill	1,900	5.00
36 in. conc. storm sewer, gran. slag backfill	1,980	6.00
42 in. conc. storm sewer gran. slag backfill	1,650	7.00
48 in. conc. storm sewer, gran. slag backfill	1,300	9.50
30 in. conc. storm sewer, concrete backfill	1,900	5.90
36 in. conc. storm sewer, concrete backfill	1,980	7.90
42 in. conc. storm sewer, concrete backfill	1,650	9.25
48 in. conc. storm sewer, concrete backfill	1,300	11.00
30 in. brick storm sewer, 2 ring	1,900	6.75
36 in. brick storm sewer, 2 ring	1,980	8.75
42 in. brick storm sewer, 2 ring	1,650	11.00
48 in. brick storm sewer, 2 ring	1,300	12.00
48 in. brick storm sewer, 2 ring in tunnel	40	30.00
Trench puddling	9,000	0.02
	Cu.Yd.	
Trench excavation	600	0.50
Days to complete, 150.		

Items—Upson Road

	Lin.Ft.	
15 in. sanitary sewer in concrete, bit. jts.	100	$1.75
18 in. sanitary sewer in concrete, bit. jts.	2,300	2.50
20 in. sanitary sewer in concrete, bit. jts.	2,600	2.70
60 in. storm sewer conc. pipe on gran. slag	100	13.50
72 in. storm sewer conc. pipe on gran. slag	4,350	15.50
60 in. storm sewer 2½ ring brick	100	14.50
72 in. storm sewer 2½ ring brick	4,350	16.00
	Cu.Yd.	
Excavation in open ditch	1,000	1.00
Days to complete, 120.		

Outfall Canals, New Orleans

TWO contracts were recently awarded by the Sewerage and Water Board of New Orleans to the McWilliams Dredging Co. for two outfall canals: (1) the Algiers outfall canal between Algiers pumping station No. 9 and the Jefferson-Plaquemines pumping station; (2) the Metairie Canal between the Southern Railway bridge and Lake Pontchartrain. The principal item in each case is excavation, amounting to 91.5 per cent of the estimated cost of the Algiers Canal and 100 per cent of the Metairie.

Algiers Canal—Excavation includes backfilling, grading and placing the material on lands adjacent to the canal. Quantity of material approximates 1,300,000 cu.yd. Two contractors submitted estimates, both proposing to employ floating dredges. The McWilliams Dredging Co. estimated $0.1187 per cubic yard; the Orleans Dredging Co., $0.1647. Unit prices were furnished on three other items:

	McWilliams	Orleans
12,000 lin.ft. y. p., 30-ft. piles driven	$1.10	$0.90
1,000 ft. capping in place	95.00	75.00
12,000 ft. lumber for bridges, incl. bolts	95.00	110.00

Total estimate, $168,745 and $226,305, respectively.

Metairie Canal—Specifications were practically the same as for the Algiers Canal. Excavation was estimated at 300,000 cu.yd., and four bids were received as follows: McWilliams Dredging Co., $0.1248, using floating dredge; John Reiss, $0.208, land dredge; Orleans Dredging Co., $0.23, floating; T. S. Brockman, $0.50, land. The total prices were, respectively, $37,440, $62,400, $69,000, $150,000.

Grading and Drainage in Westchester, N. Y.

THE accompanying tabulation gives contract (No. 261) prices for grading and draining 2 miles of the Bronx Parkway Extension from Highland Ave. to Main St., in Peekskill and Cortland, N. Y. Theodore Tenner is acting division engineer of the Westchester County Park Commission.

37,000 cu.yd. stripping and storing top soil	$0.20
83,000 cu.yd. earth excav.	0.20
24,000 cu.yd. rock excav.	0.20
2,900 cu.yd. trenching	1.00
1,000 cu.yd. trench refill	0.50
108,000 cu.yd. embankment	0.55
7,300 lin.ft. 8-in. tile underdrain	0.65
600 lin.ft. 12-in. vitr. clay or plain conc. pipe	1.00
500 lin.ft. 18-in. vitr. clay or plain conc. pipe	1.50
950 lin.ft. 12-in. rein.-conc. pipe	1.50
500 lin.ft. 15-in. rein.-conc. pipe	2.00
750 lin.ft. 18-in. rein.-conc. pipe	2.30
350 lin.ft. 24-in. rein.-conc. pipe	3.50
600 lin.ft. 30-in. rein.-conc. pipe	4.50
400 lin.ft. 36-in. rein.-conc. pipe	6.00
6 field inlets, type A	75.00
7 field inlets, type B	75.00
6,800 cu.yd. removing stone walls	0.50